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Irrigation on the Royal Murgab Estate, Turkestan, Russia

By Arthur P. Davis*

Western Turkestan is a portion of the Russian Empire, and comprises the southwestern part of Asiatic Russia. The eastern and southern portions of Turkestan are traversed by lofty mountain ranges, upon which the precipitation is very great, mostly in the form of snow. These mountains are drained by numerous streams, most of which lose their waters in the great sandy deserts of Central Turkestan, but the largest two of which reach the Aral Sea. Most of the streams are used more or less for irrigation, the total irrigated area in Turkestan being nearly 6,000,000 acres.†

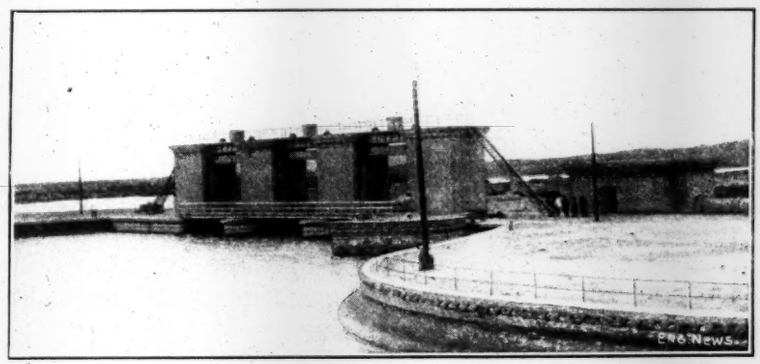

Fig. 1. Dam and Outlet Gates, Royal Murgab Canal, Turkestan

The largest and most modern irrigation system now in operation in Turkestan was built as a private investment by the Tsar of Russia on the Murgab River in Southern Turkestan. This river rises in the lofty Hindu-Kush range and flows northward, losing its waters among the sand dunes of the Kara Kum Desert, north of the ancient town of Byram Ali, the headquarters of the royal estate.

The first dam and canal system recorded in the valley was built under the authority of the Sultan Sanjar in the Twelfth Century. A canal system was provided which irrigated over 50,000 acres of land in the delta or oasis formed by the sediment of the Murgab. This ancient system was destroyed in the conquest of Genghis Khan and this, of course, depopulated the valley.

A second system of irrigation was built here by a grandson of Tamerlane, in the Fifteenth Century, and this in turn was destroyed in 1799 by the Emir of Bokhara, and again the valley reverted to desert.

After the conquest of Turkestan by the Russian Government, the valley was added to the Emperor's Estate and in the years 1887, 1888 and 1889, the dam at Sultan Bend was rebuilt for the Emperor by the engineer Kosel-Poklevsky, a Polish Revolutionist, who had been banished to Siberia, served his term and came to Byram Ali. He made brick and hydraulic lime on the ground, of which he built the dam, upon a foundation of loess, which was recognized as unsuitable for a high dam. To guard against accident, he built three dams so situated as each to stand one-third of the head. The lower two had no gates; the upper one had gates.

All these dams were built in the dry, at one side of the river. After their completion, a dam was built in the river channel of fascines, earth and rock, and the water accumulated behind during the low-water season. As it was closed, the bank was cut above the three dams to allow the river to pass through the gates therein provided, but instead of doing so, it cut a new channel, leaving the dams high and dry.

Twenty years later it was decided to provide a storage reservoir at this point, and the structure already built being unsuitable was torn away. The reservoir is formed by a massive dam shown in Fig. 1, flanked by a long earth dike. The main dam consists of a broad concrete floor or foundation resting on piles, and surmounted by massive brick piers, between which large iron gates of the Stoney type are operated. The plan and section of this structure are shown by Fig. 3. This structure was completed in 1910, and appears very substantial. This dam backs the water of the Murgab River more than 25 miles, and forms a reservoir 24 ft. in maximum depth, with 60,000 acre-feet capacity.

At the right bank of the reservoir a short distance above the dam above mentioned, a set of gates (Fig. 2) take water from the reservoir for a canal to irrigate high land in the vicinity. This canal is called the Sultan Yab, and is on the same alignment as the oldest known canal.

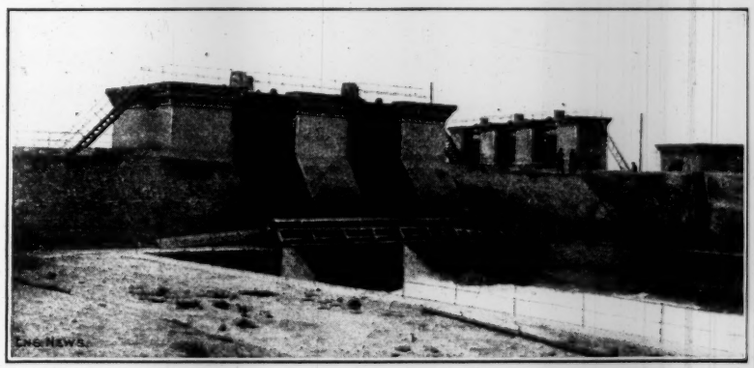

Fig. 2. Dam and Headgates, Sultan Yab Canal

A small amount of this water is pumped to a still higher level, using power generated by the falling water which passes down the Murgab River.

Just below the Sultan Bend Reservoir is the Yolotan Reservoir, formed by a similar dam at Yolotan, 12 miles below

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†A general article on irrigation in Turkestan, also by Mr. Davis, was published in our issue of Dec. 14, 1911.—Ed.

Sultan Bend, forming a reservoir of 55,000 acre-feet capacity. A plan and an elevation of this structure are shown in Fig. 4.

Below the Yolotan Reservoir is the Hindu Kush, the first reservoir provided for the present irrigation system. It was built in 1895, with a capacity of over 10,000 acre-feet, but is now nearly filled with sediment. It is said that most of this sediment came in with great floods which occurred in April and May, 1903.

The Hindu Kush dam serves as a diversion for a canal which carries water

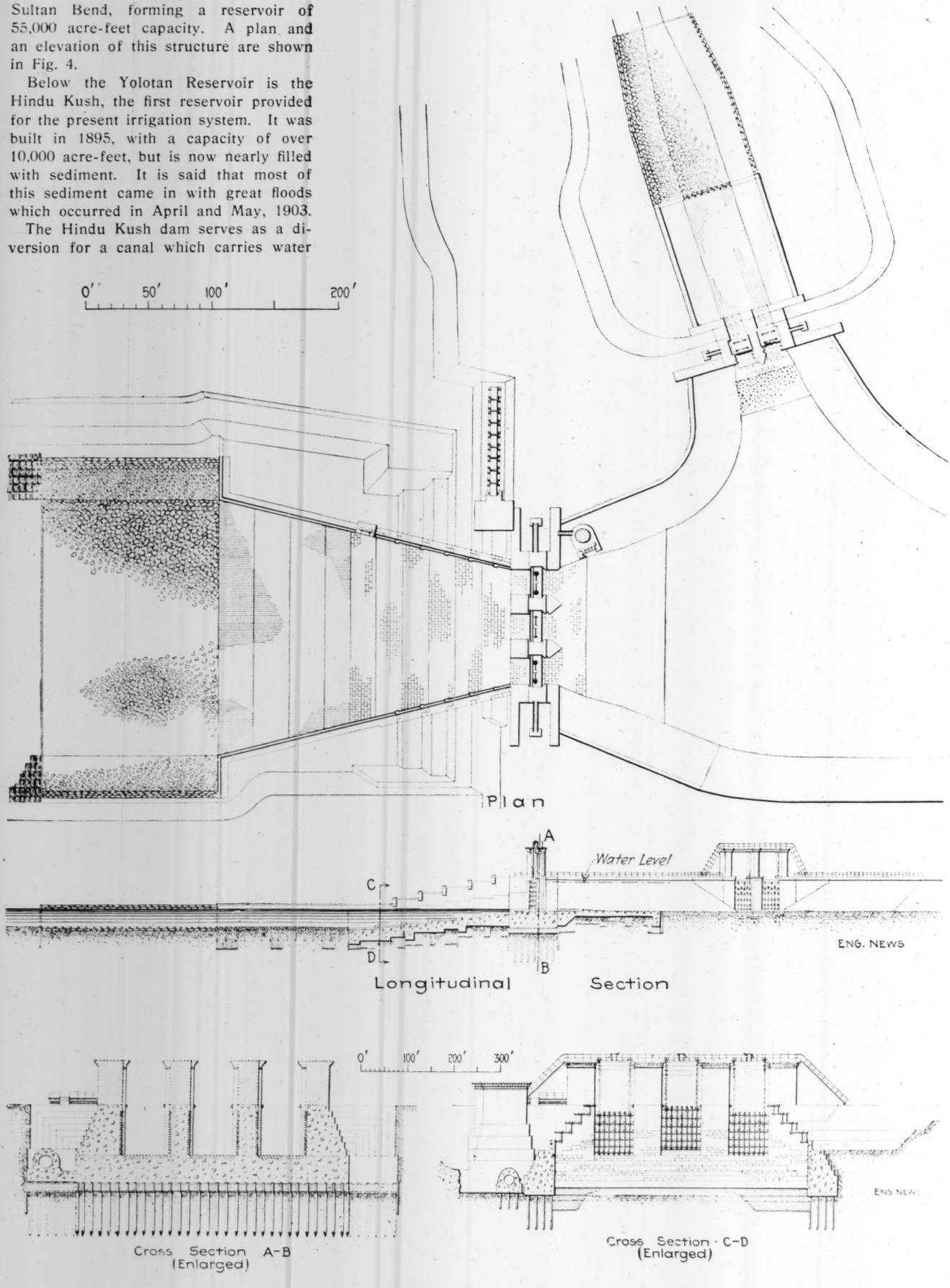

FIG. 3. PLAN AND SECTIONS OF SULTAN BEND DAM, MURGAB CANAL, TURKESTAN

to three reservoirs in the valley away from the river, formed by seven earthen dikes of nearly three miles total length, impounding 24,000 acre-feet of water.

The Hindu Kush dam (Fig. 5) has a movable top for the passage of flood waters. On the right bank is a power plant which receives water under a head of 24½ ft., from a canal leading from the dam, and generates power which is transmitted 27½ miles to Byram Ali, and there used for lighting and for running the cotton gins and oil mill. The water that serves this plant is returned to the Murgab River, and flows on to the vicinity of Merv, where it is required to satisfy irrigation rights prior to those of the Royal Estate.

The power is developed by three sets of Francis turbines, one meter in diameter, with a total capacity of about 1000 hp. One of the units is regarded as a reserve, and only two are used at once. Electric current is generated at 15,000 volts and transmitted at that tension. All the machinery was made in Buda-Pesth. The entire plant is said to have cost over a million dollars, one-fourth of which was the expense of the foundation.

As may be inferred from the line illustrations, none of the structures on the estate have rock foundations. They are built mainly on the loess foundation deposited by the Murgab River in past ages, and this enforces the liberal use of piling for foundation and protective work. The scarcity of rock is such that brush is used largely in place of riprap for protecting the banks and dikes, and in places willows are planted for this purpose.

The main canal of the valley is called the Tsar Canal, and also heads at this point. It serves about 33,000 acres of land. Most of the structures of the system are of brick laid in cement mortar, and are of the most substantial construction, a sample of which is shown in Fig. 6.

The total area irrigated in 1910 was about 43,000 acres, which was increased to nearly 60,000 acres in 1911, by reason of the extension of the canal system and the availability of additional stored water at the new Yolotan and Sultan Bend reservoirs.

A small portion of the Royal Estate is cultivated by the management, but the greater portion is cultivated by native Turkoman tenants. The staple money

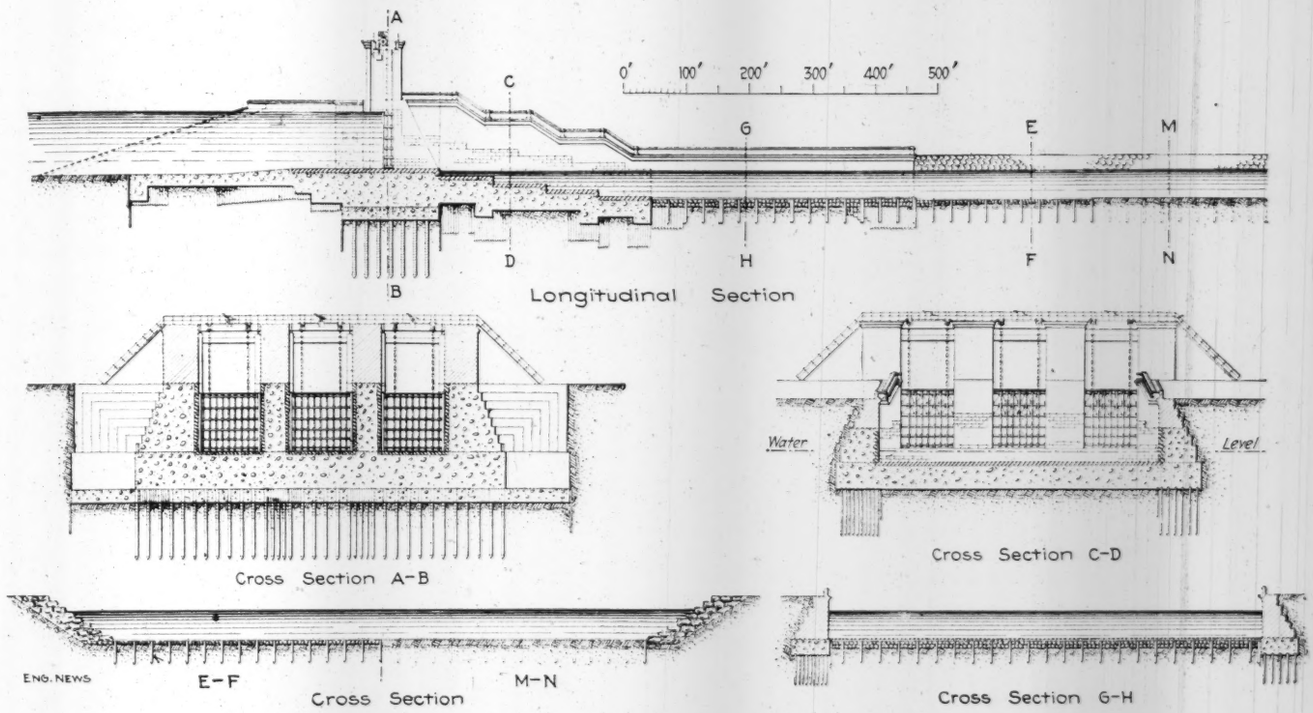

FIG. 4. SECTIONS OF YOLOTAN DAM, TURKESTAN

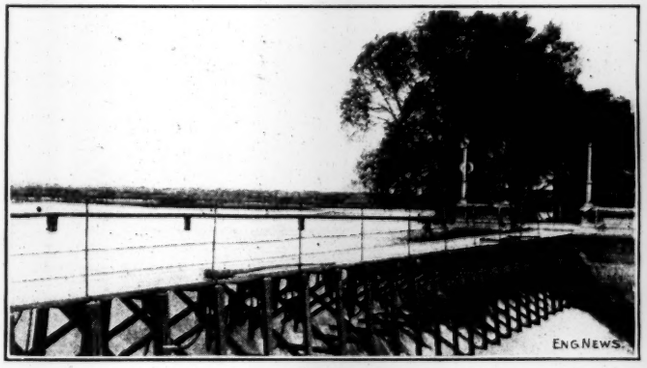

FIG. 5. HINDU KUSH DAM, WITH MOVABLE TOP, MURGAB RIVER, TURKESTAN

FIG. 6. COMBINED DROP AND DIVERSION GATES ON TSAR CANAL, TURKESTAN

crop is cotton, to which the soil and climate are well adapted.

The rental contracts specify not only the rate of rental, but the character of crop to be planted. It is said that the applications for farms are many times greater than the supply, and the recipients of the rental contracts are very grateful for the privilege.

Where cotton is raised, the rental is one-half the gross crop, and the tenant is required to deliver his entire crop to the Royal mill, where it is ginned and compressed, and the oil is expressed from the seed, a portion being manufactured into soap. An account is kept with each tenant, and the net proceeds of his half of the crop is paid to him after it is marketed.

The demands of cotton upon the soil are so exacting that continual cropping to cotton gradually impoverishes the soil, and it becomes necessary to rotate with other crops. For this purpose tenants are required to plant certain proportions of their holdings to grains or alfalfa, for which purposes lower rentals are charged, usually in cash.

An additional reason for requiring the culture of wheat and rye, is the fact that these crops can utilize a great deal of water in the spring and fall when it is not needed for cotton. It is also found desirable to produce sufficient forage and breadstuff for local consumption.

The tenants, however, prefer the money crop, cotton, and plant as much of this as permitted.

The price of cotton in Russia is relatively high, as the consumption is about double the home production, and a tariff of 6¼c. per lb. is charged on all imported cotton.

Virgin soil at Byram Ali often produces more than 600 lb. of lint cotton per acre at the first crop, but never reaches this amount afterward. The average is little more than half as much. On portions of the Murgab Estate the soil has deteriorated to such an extent that new ditches have been built to convey the water to new lands, while the old ones were abandoned. Two main causes of deterioration are noted:

(1) Continued cultivation of cotton, which in a few years reduces the yield of cotton to less than half that on virgin soil. (2) Over-irrigation and lack of drainage brings up the water table and produces a marshy or sour condition unsuitable for cultivation. This is often accompanied by the rise of injurious alkali.

The first cause can be overcome by rotation with alfalfa or other crops, especially legumes, or by leaving the land fallow for some years. The second will probably be entirely corrected by thorough drainage, leaching, and the more careful use of water. Lying fallow may also be of benefit.

Prior to 1910, the Estate was operated at a loss, in spite of the heavy investment. In 1910 a considerable profit was realized, this being the first year the reservoirs at Sultan Bend and Yolotan were placed in service. The profits of 1911 were probably still greater, as the acreage planted to cotton was increased nearly 50%. It is expected that the Sultan Bend Reservoir will fill with sediment in 10 or 12 years, and that ultimately the Yolotan Reservoir will also fill, but that in the meantime large profits from cotton culture will justify their construction.

The writer's acknowledgments are due to Prince George Obolensky, Chief Engineer of Royal Murgab Estate, for the technical information and drawings here given, and to W. W. Mackie for notes regarding the culture of cotton.

Statistics of the Mineral Production of Canada for the year 1911 are given in a preliminary report prepared by John McLeish, Chief of the Division of Mineral Resources and Statistics. Of the total production in 1911 a value of $46,197,428, or 45%, is credited to metals and $56,094,258 to nonmetallic products. Practically all of the metals with the exception of pig iron show a falling off in production compared with the previous year in so far as value is concerned. This is ascribed to difficulties incident to the long continued strike of coal miners in Alberta and the Crows Nest district of British Columbia. In the case of copper, however, there was an increased output of the metal, although the average price per pound was slightly lower than in 1910. The increase in pig-iron production was considerable, but is chiefly attributable to imported ores.

Early Railroading in Kentucky—Probably every American school boy knows that the Baltimore & Ohio R.R. was the first steam railway built in the New World; this railway was chartered in 1827, and a part was opened for traffic in 1830. Several other lines followed closely and among them the Lexington & Ohio R.R., in Kentucky. Capt. Alfred Firtle, of Louisville, Ky., in a paper read before the Engineers' and Architects' Club of Louisville on Dec. 15, 1911, gave some interesting facts about this pioneer railway, as follows:

The original charter was dated Jan. 27, 1830, and has been the model of many, if not all, of the railway charters since issued in Kentucky.

Construction was begun Oct. 22, 1831. The rails were flat bars of iron about ½x3 in. and 20 ft. long, laid on stone sills, tied at intervals with iron cross-rods. The stone sills were from 2 to 6 or 8 ft. long, about 1 ft. 6 in. wide and 1 ft. thick. About 6 in. of the upper side was faced, and the ends were dressed to give close joints between the sills. In the upper face was cut a groove 3½ in. wide for the flange of the wheel, and along the side of the groove was laid the flat-iron strip which formed the rail proper. Every 16 or 18 in. holes were drilled in the rock and into these were driven black locust wood pins. The iron strips were held down by spikes driven through them into the wood fillers. This was expected to give a very permanent and desirable roadbed, but experience soon proved that the stone would crush under the loaded cars.

One of the first locomotives was the "Daniel Boone," and it created such havoc with the stone sills that it was soon found necessary to replace them with wooden stringers. Cedar sills were used on which were placed cross-ties and on top of these the stringers to which the rails were secured.

The road was opened from Frankfort to Lexington on Jan. 25, 1835, and to Louisville in 1838.

Preservation of Power Transmission Poles*

By W. R. Wheaton†

The increasing cost of power-transmission poles in recent years and the high maintenance charges have turned the attention of power companies to some process to increase the life of the poles and to cut down the maintenance charges. The work of replacing a worn-out pole is not always as simple as it sounds. Where the current must be left on a high-tension line for all but two or three hours out of the 24, and seven days a week, and linemen must be sent several miles to replace a pole on such a line and be paid a day's wages for the two or three hours' work each day they can work on the line, the maintenance charges mount rapidly. In the past year a pole-treating plant was installed by the San Joaquin Light & Power Co., and present indications point to the installation of other plants by some of the larger power companies of California.

Various methods have been employed by the power companies of California to increase the life of transmission poles. These include the painting of the butts with carbolineum and cresote, dipping the butts in tar and asphaltum, charring, and pouring crude oil in the holes as the poles are set. While many of these treatments add somewhat to the life of the pole, they are really make-shifts. The following experiment is the most complete one that I know of, and the poles have been set long enough to show results.

In March, 1908, the company set a 30-mile line with poles of Western yellow pine (pinus ponderosa). The poles were cut in the Sierras above Fresno at an elevation of about 4000 ft., and were thoroughly seasoned before treatment. Some of the poles were given a brush treatment with carbolineum and with creosote, and the balance were treated in the open tank with creosote, zinc chloride and crude oil. The butt only was treated. Western yellow pine is very susceptible to a preservative treatment. Some of the butts were thoroughly penetrated with creosote and with zinc chloride, the average penetration (at the ground line) being 3 in. The penetration with crude oil averaged about 1½ in. The crude oil used was a heavy oil of asphaltum base supplied from the Kern River fields. In order to get a comparative life of the wood treated and untreated, stubs of untreated timber were set along the line about a mile apart.

The writer inspected this line in June,

*A portion of this article is an abstract of a paper presented at the annual meeting of the American Wood Preservers' Association, at Chicago, in January. This is supplemented, however, by additional information furnished to us by Mr. Wheaton, relating especially to the methods of treatment at the plant under his supervision.

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1910, at which time it had been set for 27 months. The untreated stubs were completely rotten. Of the poles brush-treated with carbolineum and creosote, the conditions were about the same: 27% of those treated with creosote and 29% of those treated with carbolineum showed decay. Of the poles treated with crude oil 45% were slightly attacked by decay, and of those treated with zinc chloride, 28% showed decay. The poles treated with creosote in the open tank (over 50% of the entire line was treated in this way) were all perfectly sound, and showed absolutely no signs of decay.

In August, 1911, two of the poles in this line which had received a brush coating of creosote fell over, due to the decay of the butt. During August and September, 1911, the line was examined and all of the poles which had been given a brush treatment of creosote or carbolineum were so badly decayed that each was strapped to a creosoted cedar stub.

Since the erection of our plant we have been treating the Western red cedar. We are treating the butts only (by the open tank process), and to a height which will insure 2 ft. of the treated portion being above the ground when the pole is set. There is no necessity for treating the top, since the top is not subject to decay. With this process, all we attempt to do is to fill the outer ring of sap wood on the cedar poles with creosote, and if the timber is thoroughly seasoned before treatment there is little difficulty in accomplishing this. We get a penetration which varies with the width of the sap wood, from ½ to 1 in., with an absorption of 7 to 9 lb. per cu.ft. As for the efficiency of the treatment, we have treated and untreated cedar poles in our lines which have been set for four years. The creosoted poles are still perfectly sound, while the poles set untreated have decayed through the sap wood and into the heart.

I have been asked many times why we do not use zinc chloride, copper sulphate, or some preservative other than creosote, to cut down the treatment charges. The San Joaquin valley is a hot, dry country throughout nine months of the year, and it would seem that chloride of zinc would make a very efficient preservative. It is, to a very great extent, undeveloped, and the erection of a power line furnishes a cheap power for pumping water to irrigate and develop the country. The line of yellow-pine poles mentioned above runs through a large area of such undeveloped country. Inside of a year after the erection of the line wells were driven, irrigation systems installed, and a large percentage of this undeveloped country was planted to oranges. It was found that several of the poles treated with chloride of zinc were set in this portion of the line, and after the installation of the irrigation systems these poles were in the middle of irrigated fields, the zinc was washed out of them, and the poles had to be replaced after a service of two years.

Such conditions are liable to occur on every power line, and the saving in the cost of treatment by the use of a metallic salt would not mean a saving in the end if many such replacements took place. A 50-ft. creosoted pole placed in the line means an investment of about $25. The use of chloride of zinc would cut this cost to about $24.25, and the saving is too small to be considered against the possibility of the loss of the preservative in one or two years.

In November, 1910, after having had treated poles in its transmission lines for four years, the San Joaquin Light & Power Co. decided to erect a creosoting plant for treating all timber used in its construction work. The open-tank process is used, and the poles are first seasoned for two to six months in the yard, as the process is most efficient when treating thoroughly seasoned timber.

There are two tanks of steel, 7x9 ft. and 9 ft. deep, with the top 4 ft. above the ground. The depth of the oil is about 6 to 8 ft. A stiff leg derrick with 80-ft. boom handles the poles, which are moved about the yard by trucks on standard-gage tracks. The poles are set vertically in the tank, being supported near the top by a timber platform. About 55 to 125 poles are treated at one time. The oil is cold when the poles are placed, and is then heated by steam pipes to about 212° F., which temperature is maintained for two to eight hours, depending upon the condition of the timber. Then the hot oil is run out and the tank refilled with cold oil, in which the poles are allowed to remain until a temperature of 100° is reached. They are then removed and piled horizontally, and are ready for immediate shipment.

The air in the wood cells is expanded and partly expelled during the hot treatment. When the pole is immersed in the cold oil, the remaining (rarified) air is reduced to its normal volume and thus creates a partial vacuum which results in increased penetration of the oil. The amount of the preservative which is absorbed by the wood in treating with the open-tank process depends entirely on the condition the timber is in, the amount of moisture it contains, and upon the species. Other things being equal (that is the timbers being in the same relative conditions of seasoning), the absorption depends on the species.

In treating red cedar, as we are doing at the present time, the wood is treated to resistance; that is, it is allowed to absorb all of the creosote oil that it will and the timber is treated to obtain both the maximum possible penetration and absorption. With cedar, the penetration is to a depth of ½ to 1 in. from the surface, and the absorption about 9 lb. per cu.ft. In treating timbers like Western yellow and loblolly pine, it is not a question of how much absorption and penetration can be obtained, but rather of getting a maximum penetration with a relatively small absorption, a condition which may be likened to results striven for in tie treatments by the Rueping process. With these woods the penetration is about 3 in. and the absorption 12 to 20 lb., depending upon the methods of operation. It is in the treatments of this kind that the operator of an open-tank plant can get results for a reasonable cost, or can run the cost up to a prohibitive figure.

The open-tank process provides a method of treatment which makes possible the treatment of poles at a reasonable figure. While it is used successfully in the treatment of ties and piling, it may be stated that it is an ideal process for the treatment of poles. It makes possible the treatment of the portion of the pole in the ground (the only portion that requires treatment), with results in the treated portion fully equal to that obtained by the various pressure processes, and obtains these results at a cost which is a very small percentage of what the cost would be if the whole stick were treated.

It is this low cost and the increased life which shows results in the final casting up of dollars and cents to determine whether or not such treatment pays.

The Use of Oil to Calm the Waves is mentioned in an article on the recent collision of the U. S. torpedo-boat destroyer "Warrington" with an unidentified schooner off Cape Hatteras, published in the February "Journal" of the American Society of Naval Engineers. The author of the article, Lieut.-Com. W. M. Hunt, was in command of the destroyer. The accident occurred at 12:40 a.m., Dec. 28, 1911, during a heavy southwest gale. A length of 30 ft. of the destroyer's stern was cut off and sank. The vessel was eventually towed to Hampton Roads by the revenue cutter "Onondaga." Before the tow line was attached, 70 of the crew of the destroyer were transferred in two small boats to the cutter, 12 of the crew and three officers remaining on board.

Lieut.-Com. Hunt refers to the use of oil during the transfer of the crew as follows:

> Oil was freely used by both vessels, without which it is believed the transfer would have been impossible, or at least it would have been extremely dangerous. Long sea painters were led out on the lee side of the "Warrington" and oil poured over the lee bow. Fuel oil in buckets, lubricating oil in cans and even kerosene from tanks in the bow were used. A bag filled with rope yarns was saturated with oil and placed over the side, but it did not cover enough surface, and it was found necessary to spill a pint or so of oil from cans or buckets every half minute.
>
> As a considerable quantity of this oil was washed or blown against the side and on deck, only a small quantity became effective, and it is believed that a very small quantity judiciously handled and placed would have given the desired effect. There was not opportunity to compare the effect of fuel oil with lubricating oil. Both were effective. Kerosene was too light to be of much use.

Detailing Reinforced Concrete

By Jerome Cochran*

The graphic representation of reinforced-concrete design is not uniform or standardized as it is in structural steel. There are nearly as many methods of preparing drawings as there are practitioners, which obviously is a condition that demands remedy. The specifications given below are an attempt by the author to outline rules for detailing reinforced-concrete structures which will help toward more uniform practice.

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The drafting offices of many of our large reinforced-concrete companies have become so extensive that it is important to use uniform methods as far as possible. The actual rules in use at each particular concern will vary more or less to suit the practice and facilities of that concern. The following are drawn up as a general guide, and may be modified more or less, to suit particular cases. The writer hopes that the hints herein given will be useful not only to the draftsmen employed with reinforced-concrete companies, but also to engineering students. Rules for making drawings are mainly valuable in giving greater uniformity.

Drafting-room Standards and Organization

STANDARDS — The drafting room of every reinforced-concrete concern should be provided with a set of the firm's standards, which have all the instructions and regulations intended to apply to the design and execution of all work in the drafting room. These instructions in regard to the drafting room should be made as complete as possible and with the idea that all men are beginners. A strange draftsman entering a new office is generally ignorant of the principles of that firm's system of reinforced concrete. It is one great fault of persons compiling instructions and regulations that they leave their work 50% completed. More time spent in the preparation of these standards will greatly increase the efficiency of the drafting force, especially the beginners. No variation should be permitted from these drafting-room instructions without special permission from the head of the department.

ORGANIZATION—The drafting room is generally divided in the grades of designers or squad bosses, draftsmen and tracers. Usually there is a chief draftsman or head of the department who has general supervision of all work and assigns the work to the various men under him, whom he considers best fitted to get out the drawings for it.

DESIGNERS OR SQUAD BOSSES—To ensure the proper handling of the work in the drafting room, all the information and data connected with each new contract should be handed to a designer, or squad boss, who is expected to familiarize himself with the estimate and correspondence relating thereto and the conditions of the contract affecting the design. He will be expected to see that all orders, drawings and details required in his jobs are properly executed and checked. It will be his duty to see that all orders are placed in sufficient time for shipment according to contract, that all details are complete and so clear the contractor can make no mistake in placing the steel.

The designer or squad boss will also be expected to see that all slabs and girders are designed as economically as possible. As the work progresses he must at all times keep himself informed in regard to the relation between shipped and estimated tonnage. Care must be exercised to keep the design within the estimate. If this is found to be impossible the fact should be immediately reported to the head of the department and such a report must include the reason for the same.

Specifications must be carefully read and all paragraphs which affect the design must be marked with a colored pencil. Under no circumstances will the designer or squad boss be allowed to make any reductions in the live and dead loads, or to use higher stresses than those specified in the specifications without special permission from the head of the department.

A record-card file is kept in the office to which access can always be had. In this file will be found the contract number, the instructions with regards to shipping dates, fabrication and kinds of material included in the contract.

The designer or squad boss will be expected to keep notes covering the various features of the job, such as special instructions from engineers and architects, and the cause for overrunning an estimate. He will be expected to see that the calculations on the job are kept carefully and in such form that they can readily be referred to. He will also be expected to inform the head of the department of any failure of the design or estimate that may seem questionable.

DRAFTSMAN'S EQUIPMENT—Each draftsman should be supplied with a sketch book by the company, in which he should make all his notes, calculations and data referring to his work, and under no circumstances should notes of value be made on loose sheets. Many figures which a draftsman makes, however, will be on scratch paper, but all figures which may be needed for future reference and for consultation when the changes made by the checker are gone over, should be kept in a permanent and methodical form. Every entry should invariably be commenced with the subject and date, and full notes made of data on which the calculations were based and the results clearly stated. It cannot be too strongly insisted that intelligible notes be kept of all calculations of design and of any important points which it may be desirable to preserve. The computations should include all minor details, which are sometimes of the utmost importance. These notes as stated above should always be headed with the date, the name of the work to which the notes apply, and the name of the draftsman or designer. These books should remain the property of the company.

The draftsman must have a ready knowledge not only of the principles of drawing, but of the conventional methods of detailing reinforced concrete, and any device or system that will lessen the cost and difficulty of construction as regards the arrangement of the reinforcement without sacrificing strength, is desirable. When the tracing is complete, the draftsman should look over it carefully, trying to detect any errors, as all such count against him. In fact, a reputation for making mistakes is perhaps the worst a draftsman can make for himself.

The draftsman should be familiar with the use of the slide rule, and should use it to calculate the area of steel required in beams, slabs, etc., and the compressive stress in the concrete, etc.

A draftsman should have at hand reference books in order that he may look up any point in theory with which he is not familiar. A few may be mentioned here, but, of course, for structures out of the ordinary special works should be consulted. The most useful are:

Brayton's "Standards—A Pocket Companion for the Uniform Design of Reinforced Concrete"; Brook's "Reinforced Concrete: Mechanics and Elementary Design"; Buel's "Reinforced Concrete"; Corrugated Bar Co.'s "Designing Methods (a series of bulletins on designing methods for reinforced-concrete construction)"; Dodge's "Diagrams for Designing Reinforced Concrete Structures"; Gillete & Hill's "Concrete Construction"; Hawkesworth's "Graphical Handbook for Reinforced Concrete Design"; Heidenreich's "Engineers' Pocketbook of Reinforced Concrete"; Mensch's "Architect's and Engineer's Handbook of Reinforced

Concrete Construction"; Pittsburg Steel Products Co.'s "Blue Book (containing information and tables relative to the use of Pittsburg standardized reinforcement for concrete)"; Reid's "Concrete and Reinforced Construction"; Reuterdahl's "Theory and Design of Reinforced Concrete Arches"; Taylor & Thompson's "A Treatise on Concrete, Plain and Reinforced"; Trussed Concrete Steel Co.'s "Kahn System Standards (a handbook of practical calculation and application of reinforced concrete)"; Turneaure & Maurer's "Principles of Reinforced Concrete Construction"; Warren's "Handbook on Reinforced Concrete." Access to ENGINEERING NEWS, *Engineering Record*, and other engineering journals will be valuable. An individual card index should be kept in order that any subject may be looked up when occasion requires.

It would be well if all of the above books might be found in every drafting room; but if the expense prevents that, the ambitious draftsman should at least make himself acquainted with their contents. These works will also be found of great value to designers and estimators.

General Requirements

DATA—Before starting on the drawings for any particular structure a draftsman should make himself perfectly familiar with all data (contract, estimate, general plans, specifications, etc.) in the company's possession. Examine these data carefully with the view of referring any discrepancy, doubtful or ambiguous point to the head of the department at the earliest opportunity, and avoiding any unnecessary delay. Time spent in a general preliminary consideration and plan of action is generally well spent. If further information is required, it should be asked for at once. A draftsman should never be ashamed to ask intelligent questions.

TRACINGS AND SKETCH SHEETS — All working drawings liable to repetition must be traced and blueprinted. All temporary details, requiring only one copy, may be made on sketch sheets and press-copied.

SIZE OF DRAWINGS—Drawings may be made 12x24 in., 15x30 in., 18x36 in., 24x36 in., 24x42 in., or any convenient size between trimming lines.

BORDER LINES—Border lines will consist of a single heavy line, leaving a ½-in. margin inside of the trimming line. The thickness of the border lines should match the work in hand, together with the size of the sheet. It is the first thing to be drawn in a pencil drawing, and the last thing in an inked drawing.

APPEARANCE OF DRAWINGS—A drawing should have a workmanlike appearance or it will not inspire confidence in its correctness. The general arrangement and the lettering are the main features so far as appearance is concerned.

Scale, Lettering and Working Lines

SCALES—The selection of a scale for a drawing depends upon the size of the work. The scale used must be large enough to show the details clearly. In general, plans should be made to a scale of ¼ in. = 1 ft. for ordinary work, and for very complicated work even larger scales should be used. Plans for very straight work may generally be made ⅛-in. scale. Do not make drawings larger than necessary. The scale should be noted on the drawings.

Sections should be ½-in. scale or larger, if necessary. This applies to detail sections. General sections through a building are exceptions and may be made to a smaller scale.

LETTERING—The general appearance of drawings depends to a certain extent upon having the lettering, titles, etc., neat, legible, appropriate in character and uniform in style. In fact, there is no part of a drawing so important as the lettering. A good drawing may be ruined in appearance by lettering done carelessly. The lettering must be plain, neat and easily legible, however, time should not be wasted in making fancy letters. The letters and figures should be made as carefully as is consistent with rapidity. Plain block letters and figures written vertically are most easily read. All letters must be neat and large enough to show up well on the blueprint, but they should not be more conspicuous than the drawings.

STENCILING — Stencil letters may be used to bring out important parts of the drawing, such as beams and section marks. A stiff, short stencil brush should be used. Care must be taken not to have too much ink on the brush or the stencil work will be smeared or blurred.

WORKING LINES—Drawings should be made with the fewest lines possible consistent with clearness. Fairly heavy lines should be used for drafting so as to give a good, clear blueprint. The lines must be bold and clearly defined in proportion to the scale. Fine lines should be avoided except for dimension lines. In other words, wherever the size of scale will permit, lines should be made firm and heavy. For smaller scales the lines must be lighter and greater care must be used to show the details clearly.

DIMENSION LINES — Dimension lines should be made in very fine black lines, either dotted or continuous. Red does not print well and should be avoided. It is necessary, however, to have such lines very fine and uniform, as otherwise they may be confused with the drawing itself. A suitable blank space should be left for the dimension proper.

Figures and Dimensions

TERM "DIMENSION"—By the term "dimension" is meant the figure, the notation marks, the line and the arrow-heads.

REQUIREMENTS OF DIMENSIONS—Every dimension should indicate with unmistakable clearness two things: (1) the points or surfaces between which measurement is to be made; (2) the distance to be measured. These are the chief requirements. There is nothing on the whole drawing so important as the dimensions.

FIGURES—All figured dimensions on drawings should be plain round vertical figures, formed by a line of uniform width and sufficiently heavy to insure printing well. The figures must be entirely free from ornamental or superfluous features, so that they may be both easy to read and easy to write. Their shapes should be such that it is practically impossible to mistake one figure for another. No thin or doubtful figures will be tolerated.

If sloping lettering is used on the drawing, sloping figures should also be used.

The size of the figures should be suited to the other parts of the dimension, and should be chosen with discretion. A suitable size for ordinary work is $\frac{3}{16}$ in. Figures must not be less than ⅛ in.

NOTATION MARKS—It is preferable to have the notation marks for the foot and inch slope in the opposite direction to the figures and thereby avoiding the likelihood of being confused with the figure 1, especially in connection with the numerator of a fraction. The reversing of the notation marks gives additional character to a dimension.

ARROW-HEADS — A dimension arrow-head should never be placed so that it is interfered with by any other line. Arrow-heads should always be in black and made with great care, their points just touching the line to be measured.

FRACTION LINE—No diagonal-barred fractions should be used. The horizontal fraction line is better than the sloping one, not only because it is less likely to be scribbled, but because it makes a neater looking and more compact fraction.

DIMENSIONING — Dimensions should always indicate the finished size of the member or structure, without any reference to the scale of the drawing. A dimension not agreeing with the scaled distance, or which has been changed after the drawing has been made should be heavily underscored. The dimensions should be placed so as to be the most convenient for the workman in the field and not scattered over the entire drawing. Dimensions should be clearly given in some one view, and not repeated in other views. Dimensions must never be crowded so as to impair clearness. Extension lines should not touch the outline. A dimension should never be placed on a center line. Dimensions should read from the bottom and right side of the sheet, no matter what part of the sheet they are on.

MAIN DIMENSIONS—Only such dimen-

sions as are necessary for laying out the work in the field or as assist materially in checking the plan, should be noted on drawings. Main dimensions which are necessary for checking, such as center to center distances, overall dimensions, story-heights, etc., should be repeated from drawing to drawing. Unnecessary repetition of dimensions must be avoided. All drawings must give general dimensions. In other words, the essential dimensions must be present, but the non-essential ones should be left off, for too many dimensions are just as undesirable as an insufficient number. Always give an overall dimension and place it outside of detail dimensions. Never require the workman to add or subtract figures.

REFERENCING DIMENSIONS—All dimensions should be referenced to some definite base line and working point, as the center-line or track of the center-line of the structure and their intersection.

FRACTIONAL DIMENSIONS — Dimensions of reinforced-concrete structures should not be given closer than to quarters of an inch, except where unavoidable.

EXPRESSING DIMENSIONS — All dimensions on drawings when 1 ft. and over, should be in feet and inches, thus 16 in. would be marked "1′ 4″"; when under 1 ft. use inches, i.e., seven and one-half inches write "7½″." Width and depth of beams and dimensions of columns should always be expressed in inches in their respective schedules or on the elevations, plans or sections. Thus "12″x26″ beam" or "22″x22″ column." The breadth of beams should always be given first and then the depth, even if the beam be a very shallow one.

FOOTINGS — All corners of footing courses and neatwork lines on footings should be definitely located. All intersections of planes should be definitely located.

DISTANCE FROM BASE OF RAIL—Elevations and distances from base of rail of all important points in concrete bridges, piers, abutments, etc., should be given on plans.

BATTER — Exact batters on inclined faces, as well as determining dimensions, should be given.

PILES—Piles should be located in rows, the spacing being perpendicular and parallel to the rows, and the end pile in each row being definitely located.

ARRANGEMENT OF DRAWINGS

LAYING OUT WORK—If the design be a simple one, the estimate sketches may be all the laying out that is necessary, and draftsmen can proceed to make working drawings from these sketches. In any case it is very important to have the drawing started right with the structure arranged as it should be. There is a best place to begin on a structure and a most logical order in which to work it up, not only each drawing, but every detail. If this is followed very little erasing will have to be done. It is generally easier to redraw a sheet, however, than to make the necessary corrections to one that has been wrongly laid out. There is an advantage in compactness, but clearness should be the first consideration. Arrange the details and plan so as to well fill the sheet.

SCHEME OF THE DESIGN — Drawings should tell at a glance the general scheme of the design. They should show clearly the quantity and exact position of all reinforcement; the method of its anchorage, where continuity or extra bonding are required; detailed size of all the concrete work; and in short all details affecting strength or appearance. Drawings should show clearly general arrangements and details of parts. Care must be taken to make them plain and complete, and as simple as possible, so that the unskilled workmen in the field can understand them. Each drawing should be made complete in itself. In other words, make the drawing so plain that it will explain itself and that only gross negligence on the part of the contractor will allow a mistake to be made in using it.

VIEWS—The number of views is determined by that judgment which serves common sense. As many views should be given as will show the construction of every piece of masonry. Cloth and paper are cheaper than men's time, and it is better to use a little more of this material in drawing extra views than to have any confusion in the erection of the structure. The selection of a view or views which shows the piece of masonry in the most comprehensive manner should always be made. Do not give views, or parts of views, which are unnecessary. In structures which consist of several parts, a diagram should be added showing the relative location and elevation of the different parts.

EXPLANATORY NOTES — Notes may be used when they will save considerable drafting, but should generally be avoided. Making the drawing complete will guard against mistakes in the office and the field. Use uniform methods, putting explanatory or general notes in the same part of all drawings. Do not change existing customs without exceptionally good reasons. Uniformity of drawings not only saves much time when looking for information in the field, but also much liability of mistake from oversight. A note should be so worded that its meaning cannot possibly be mistaken or misunderstood. Notes must not be too abbreviated. All notes must be in short sentences, explicit and concise. It is not permissible to refer to a reference; the drawing referred to should give full information.

TITLE—A title is an essential part of any drawing, and an invariable place on the drawing must always be provided for it. The title should be arranged uniformly for each job near the lower right-hand corner of the drawing (for convenience in referring to the drawings after they have been filed), printed in plain vertical or sloping letters. The title lettering on a drawing should be the most prominent lettering. The title should be lettered freehand in single-stroke capitals, either upright or inclined, but never both styles in the same title. The initial letter of every word, excepting prepositions, should be taller than others and all letters in a word should be close together, but at the same time sufficiently separated for clearness. A title generally looks better without lines drawn underneath. This is entirely optional, however; if lines are put under they should not be too close to the letters. The wording of titles should be submitted to the head of the department for approval. All lines in the title must be arranged symmetrically with reference to a center line.

Every drafting room has its own standard form for titles. In large offices this is often printed in type on the tracing cloth. Sometimes the title is put on with a rubber stamp, and inked over while wet. Printing is the most satisfactory method when the number of drawings turned out is large.

Adjacent to the title the following information should be placed in the extreme lower right-hand corner of all drawings: Contract number; number of sheet; total number of sheets in the job; name or initials of the draftsman and the checker; date and scale. Above this may be placed the name of the reinforced-concrete concern. The contract number should be put in large figures so it will strike the eye at once. The initials or name of the designer should also appear on each drawing. The date and the name or initials of the persons responsible for the drawing should be in very small letters.

Drawings requiring the approval of officers should have proper place provided for that purpose, preferably near the title.

NUMBERING DRAWINGS — When there are several sheets to one set of plans, they should be numbered by different letters, such as 78-A, 78-B, etc. Each distinct piece of work should have a separate job number.

REFERENCING—Any number of drawings may be referred to the first drawing, but the first drawing should have a note stating what drawings have been referred to it.

SECTIONS, ELEVATIONS, ETC.

PROPER POSITION—Show all elevations, sections and views in their proper position—looking toward the member. Place the top view directly above and the bottom view below the elevation.

GENERAL SECTIONS—If a certain work requires more than one drawing, show general sections on the first drawing only,

but place notes on each drawing showing clearly where general sections are to be found. In a sectional view the portion of the object which is cut away and nearest the view is removed, and what is left is shown in the sectional view.

COMPLETE DETAILED SECTIONS — If there is any doubt as to the make up of a section, a cross-section should be shown giving on this the make up of the section and important dimensions. Show complete detailed sections of any "out-of-the-ordinary" parts of the work, such as cantilevers, connections to structural steel, heavy concentrated loads framing with beams, eccentric connections, etc.

LOCATION OF SECTIONS—Sectional views can be placed, if convenience demands it, at any place on the sheet, but always indicate where the section is taken by noting carefully below section. The direction in which a section is taken should be indicated by arrows on the line representing the cutting plane.

CONCRETE SECTIONS—Concrete sections may be indicated by blackening the reverse side of the tracing with pencil. A blue crayon-pencil should never be used for this purpose when a print is to be taken from the tracing, as it will not show up.

Concrete sections may also be indicated by stippling with triangular marks in the following manner: Stones are first placed at random with a single continuous stroke and varying pressure of the pen, followed by heavy, irregular-shaped dots placed sparingly between the stones. The tint of the whole should be finally finished by placing judiciously small dots, indicating particles of cement, which will give the necessary finish to the section, and make it resemble very closely real concrete. In "gravel concrete" the gravel should receive rounded outlines instead of irregular shaped figures. For the placing of the heavy black dots in "cinder concrete" a heavy lettering pen may be used, each dot being made by a single application.

The above conventional methods of representing concrete sections may give rise to some confusion when the sections are to indicate the positions of reinforcing steel, especially when the reinforcement is shown by circular or square black sections. Unless the stippling with triangular marks to represent concrete is carefully done, the black sections representing the reinforcing steel may be taken for part of the concrete. In order to avoid this confusion, the concrete may be represented by light, broken, diagonal lines.

Any one of the three methods mentioned above will be acceptable for showing concrete in section, provided it is properly executed. Blackening the reverse side of the tracing with pencil to indicate concrete sections will require less time. Care, however, must be taken not to darken the section too heavily or the reinforcement will not show up clearly.

STEEL REINFORCEMENT

ECONOMY OF ARRANGEMENT — In the design and arrangement of reinforcement, due regard should be given to the cost and difficulty of construction. Simplicity and duplication in the reinforcement will result usually in a large saving.

INDICATING REINFORCING STEEL—Plans and details of reinforced-concrete structures should show the size, length and exact location of all reinforcing material, and should provide for proper connections between the component parts, so that they cannot be displaced. The detailer should always remember that though the contractor may be an engineer and have the reputation of going good work, yet he is relying on the drawings to give him all the necessary information to properly place the reinforcing steel.

In general, the sizes and lengths should be shown on the elevations and the spacings on the cross-sections. In highly reinforced work the concrete dimensions and the reinforcement details should be shown on separate views. Large-scale cross-sections and diagrams should be added where the bar arrangement is complicated.

In side elevations, the reinforcing system or skeleton of rods and wires should be shown by fairly heavy, short, double or single dashes, and by solid black sections, giving circular or square shape of such wires or rods, where this reinforcement appears in cross-sections. The reinforcement is thus allowed to stand out bold and clear.

TYPE OF BARS—Reduce to a minimum the number of different types of bars on each job.

BEARING OF BARS—All reinforcing steel must have a full bearing on the adjacent supports.

LENGTH OF BARS — Bars should be called for in lengths which can be cut from stock lengths with minimum waste. Bars should be called for in even feet, if possible, and where other lengths are necessary try to vary the lengths by multiples of 3 in. As few different lengths as possible should be used. Avoid ordering bars in ¼-in. lengths.

LENGTH OF SHORT BARS—In arriving at the length of bars under 5 ft. long, such as dowels, etc., where a variation of a few inches will not make any difference, the scheme of marking "±3"" after the length of bar required may be adopted. This enables the shop to use scrap material without re-shearing. For examples, "4-⅝" Squares, 4′ 6″ ±3"" means that the bars may vary from 4 ft. 3 in. to 4 ft. 9 in. in length.

BENDS IN BARS—Unnecessary bends, bends in heavy bars, and many bends in the same bar should be avoided wherever possible. In other words, reduce to a minimum the number of bends in each bar and the number of types of bent bars required on each job. The fewer bends in bars the better. Small sized bars of low elastic limit should be used for stirrups and for reinforcement which must be bent to a small radius.

BENDING HOOKS ON SMALL BARS—For cold bent hooks it is generally necessary to have at least 6 in. of length in the hook on base size material for the machine to grip. The bars should be marked ± (plus or minus), which means that the dimension so marked is not absolutely accurate, but may vary as much as 3 in. in order to allow for any difference caused by the bending. Cold bent hooks are generally bent around a 3-in. pin so that the radius should not be indicated unless it has to be more or less than 1½ in. Right-angle bends must be hot bends if not enough material is allowed for machine grip.

If the length of the hook is absolutely fixed it must be so noted on the detail.

USE OF SIGN ± —The plus or minus sign should be placed on one dimension on each bar when the bending is complicated, and on one dimension of each bar that is to be hooked.

BENDING DIAGRAMS OR SKETCHES—Bending diagrams or sketches should be shown for all bent bars. The lengths of bars should be measured along the center line. The dimensions on bends should always be from out to out except in the case of stirrups, column hooks and column spirals. Do not attempt to combine many pieces in one sketch if by so doing too many notes are required.

SHOP MARKS ON BENT BARS—All bent bars should be given some reference mark. There is much variation in reference to the marking of bent bars. These marks should consist of capital letters and numerals, or numerals only. No small letters should be used. The following scheme is suggested: For the first ⅜-in. bent bar mark it 300, the second 301, and so on; mark the first ½-in. bent bar 400, the second 401, and so on. For ⅝-in. bent bars use 500, ¾-in. use 600, and so on. The hundredth figure will indicate at once whether the bar is a ⅜-in. bar or a ⅞-in. bar; thus 704 would indicate that ⅞-in. bars are to be bent and probably it is the fifth in the series of ⅞-in. bars having different bends. The word "marked" in abbreviated form may be used in front of the shop marks: thus "14—¾" Rounds 26′ 3″ lg. Mk. 609."

BILLS OF MATERIAL—A complete bill of material should appear on *each* drawing. It should be placed directly above the title; and it is a good plan to block out a space for it immediately after the title has been allowed for. Every piece of reinforcing steel shown on the drawing should be accounted for on the bill of material, so that any clerk in the office can order from it independently of anything else. The material bill on each

drawing also shows to the contractor the exact amount of steel called for by that drawing, without having to figure it out.

In the table of the bill of material, the first column should contain the number wanted. The second column should contain the size and type of bar, i.e., round or square. The third column should contain the length of the bar, expressed in feet and inches. The fourth column should state whether the bar is a bent one. The fifth or last column should contain an identifying or shop mark which is exactly the same as the one placed on the piece of reinforcement shown on the drawing, and may be a letter or a number as stated above. If there are no bent bars shown on the drawing, the last two columns will, of course, be omitted.

List the smallest sizes and shortest lengths first, keeping the round and square bars separate.

Foundation Plans

Size of Footings, Etc.—On this plan should be shown the size of all footings, the quantity of steel in them and their elevation referred to some fixed line, such as the nearest floor line.

Dowels—All dowels are anchors and their connection in this portion of the structure should be clearly shown.

Working Lines—Footings should be shown in full lines as if the floor and the soil covering them had been removed.

Bill of Material—A list of material as it is to be ordered should be placed upon each foundation plan. This includes all the steel that will be required to install that portion of the work as shown on the drawing.

Column Drawing or Schedule

Completeness of Details—This drawing should give all the necessary information to permit the proper placing of all material required in the columns. As the columns represent the most vital part of a building, since the failure of one may cause the fall of the entire structure, the detail must be so complete that the contractor cannot possibly omit any of the steel or fail to get it in its proper location.

Numbering Columns—Number all columns consecutively 1, 2, 3, 4, etc., no matter if all columns have the same load and contributary floor area.

Cross-section—The column detail should include a cross-section of the column with the dimensions placed thereon, including all recesses or keyways for bonding the curtain walls. The section should show the location of the vertical reinforcement and the hoops or stays.

Special Connections and Anchors—The drawings must also contain sufficient details to show all special connections and anchors between the columns and the rest of the structure.

Splicing Column Bars—Column bars should be spliced at floor levels, where beams and slabs give lateral supports. Vertical column bars, unless otherwise specified, should extend above the floor level the following distances: ½-in. to ⅞-in. bars, 18 in.; 1-in. and 1⅛-in. bars, 21 in.; 1¼-in. and other bars, 24 in. Drawing should indicate clearly that the bars are to be wrapped with wire.

Fireproofing—The minimum thickness of a fire-retarding coating, covering the reinforcement for columns should not be less than 1½ diameters or 1½ in.

Bill of Material—A list of material as it is to be ordered should be placed upon the column drawing or schedule. This includes all the steel that will be required to install that portion of the work as shown on the drawing.

Shop-fabricated Spirals—When shop-fabricated spirals are used the spiral should be stopped 2 in. above the bottom of the lowest beam unless otherwise specified.

Lap of Column Bars—Vertical column bars, unless otherwise specified, should extend above the floor level the following distances: ½-in. to ⅞-in. bars, 18 in.; 1-in. and 1⅛-in. bars, 21 in.; 1¼-in. and other bars, 24 in.

Column Schedule—A column schedule should be placed upon the drawing.

Floor and Roof Plans

Layout—The layout of beams, girders and floor slabs should be made as simple as possible.

Working Lines—The more important structural elements, such as beams and columns, should stand out in bold relief. The location of every column should be clearly shown, either by cross-hatching or otherwise. Beams should be indicated by heavy broken lines, bars in floor slab by fine full lines.

Arrangement of Steel Reinforcement—Floor and roof plans must be drawn in such a way that every piece of steel required in the portion of the structure which the plan represents shall have its location clearly shown. On the plan itself should be shown slab steel, continuity bars over columns, girders or bearing walls, anchor bars or any other steel required in the slab or in the top of the beams and girders.

Reinforced-concrete Connections—As the connections between reinforced-concrete members are frequently a source of weakness, drawings must include complete details of all such connections.

Structural-steel Connections—All details must be carefully executed, particularly where concrete construction is used in connection with structural steel. In this class of construction the anchorage between the two classes of material must be carefully considered.

Indicating Slab Bars—In ordinary straight work it is not necessary to indicate every bar in the slab. A few lines to indicate the general arrangement are sufficient.

Bearing of Bars—All bars in beams and girders should bear at least 6 in. on their supports. Where beams and girders are of about equal depth so that the steel in beams rest on or near the steel in the girder, stirrups should be placed to carry the ends of the bars and to distribute their bearing. Steel in beams should rest at least 7 in. on brick walls, and even more for important beams and girders, depending on the design. Slab steel should have a bearing of at least 4 in.

Spacing of Bars—The minimum spacing of parallel bars in slabs should not be less than 3 in. Two layers of bars perpendicular to each other should be in contact, the bars forming the main reinforcement being in all cases placed undermost.

The minimum distance from the center of any bar to the edge of beam or girder should be two diameters, or 1½ in. The minimum distance c. to c. of any bar in the same layer should be 2½ diameters for round bars and 3 diameters for square bars, and not less than 2 diameters between centers of bars in different layers. The spacing between two layers of bars should never be less than ½ in. in any case. The longitudinal spacing of stirrups or bent rods, should not exceed three-fourths of the depth of the beam

Length of Bars—If framing between concrete beams, bars in floor slab should be ordered about 1 or 2 in. less than the center to center distances of beams, depending on width of beams. (Some offices require that all straight bars in slabs are to lap 3 in. beyond center of beam at each end, making a 6-in. lap.) If framing between structural-steel work, allow about 1 in. clearance between faces of steel work, or when bars are specified to be hooked over I-beams, allow 3 in. for the hook on each end beyond the flange of the I-beam.

Steel in beams framing into girders or columns should be ordered to extend to within ½ in. of the centers of the girder. (Some offices require that all straight bars in beams are to extend 4½ in. beyond the center line at each end, thus giving a 9-in. lap.) Steel in beams framing into wall columns, wall girders, or girders around openings should be ordered to extend to within 2 in. of the outside face of the columns or girders.

Never order bars in ½-in. lengths.

Fireproofing—The minimum thickness of a fire-retarding coating, covering the reinforcement should be for slabs not less than 1½ diameters, or ¾ in., and for beams and girders not less than 1½ diameters or 1½ in.

Dimensions of Beam—The size of the beam is the full width of the beam and the height is the distance from top of slab to bottom of beam. No beam is to be less than 7 in. wide unless the span is under 10 ft.

LETTERING BEAMS AND GIRDERS—All beams and girders must be marked by letters or numbers. Stencil letters may be used to bring out the beams and girders. The first-floor beams may be marked "A-1" or "101," etc., and the second floor beams "B-1" or "201," etc., prefixing the roof in all cases with the letter "R." The beams on the first floor may also be marked A, B, C, etc., throughout the alphabet and then start with 1, 2, 3, etc.; the other floors being treated in a similar manner. It is not necessary to give similar beams on different floors the same mark.

LOCATION OF STRUCTURAL MEMBERS—Column centers and numbers, size and location of openings, size and location of beams and girders, thickness of slabs, etc., must be given on each plan.

REFERENCE LINE—Some fixed reference line should be assumed on each floor or roof plan to which all dimensions must be given. This line must appear on all drawings. The face of the concrete construction, the building line, the face of the pilasters, or any other line that may be easily identified on the engineer's or architect's plans may be assumed as this reference line. If this line is not a part of the concrete construction it should be shown as a dot and dash line and notes should be placed on the plan to show its meaning.

INDICATING BEARING WALLS—Drawings should be laid out to show concrete construction only. Walls should not be shown unless they are required for bearing. Where such walls are entirely covered by the concrete construction, they must be indicated by dotted lines. If the outside walls are used to carry concrete beams or slabs and if these beams or slabs do not extend to the outside edge, full lines must be drawn to indicate both the outside face of the walls and the outside edge of the concrete construction. The inside face of the wall must be shown by a dotted line and the amount of bearing must be shown for beams, slabs and girders by figures.

BEAM AND GIRDER SCHEDULE—A beam and girder schedule should be placed upon each drawing. It is not necessary to show the steel in beams and girders on the floor or roof plan, as this can be done better in the schedule itself. Continuity bars over columns, girders or bearing walls, however, should not be shown in this schedule, but should be clearly shown on the plan.

TILE AND JOIST CONSTRUCTION—Where beams carry tile and concrete-joist construction, the size of the Tee must be clearly shown. It is not sufficient to only note the size in the beam schedule. Tees should be shown by sections on the drawing or by dash lines on the plan indicating the point where the tile should stop. Too much emphasis cannot be placed upon this very important point and should always receive the most careful attention.

SPECIAL DETAILS—Any other steel that cannot be clearly indicated either on the plan or in the beam and girder schedule must be shown by special details

BENDING DIAGRAMS—Diagrams must be made for all bent bars in beams, girders or slabs. Start to bend bars at the quarter point of center to center dimensions of beams. If more than two bars are bent in a beam, the bends should not all start at the same point. For example, if three bars are to be bent, one bar should start to bend at the quarter point and the other two at about the fifth point.

BILL OF MATERIAL—A list of material as it is to be ordered should be placed upon each floor or roof plan. This includes all the steel that will be required to install that portion of the work. If several floors are shown upon one drawing, list the material for each floor separately. Never include more than one floor in the bill of material. Since no useful purpose would be served by delivering all of the steel for, say, a six- or 10-story building, on the site at the beginning of the work, thereby entailing large storage capacity and much time on the part of the material clerk, the steel is sent to the job floor by floor.

WALLS

WALL CORNERS—Use ample steel to tie together joining walls at corners.

BELT COURSES, CORNICES, ETC.—Use ample reinforcement in belt courses, cornices, etc., to connect them to main walls. In general, more reinforcement is needed to prevent cracking at changes of thickness than in walls.

BILL OF MATERIALS—A list of material as it is to be ordered should be placed upon the drawing showing the reinforcement in curtain or retaining walls. This includes all the steel that will be required to install that portion of the work as shown on the drawing.

CHECKING AND CORRECTING DRAWINGS

CHECKING DRAWINGS—The amount of checking required will depend entirely on the care with which the work has been laid out and the drawing made. If laid out by an experienced draftsman that knows his business, very little checking will be required. It is false economy to think that the cost of making reinforced-concrete details will be decreased by employing cheap and inexperienced men. The drawings made by such men usually cost in actual wages paid out for making them about twice as much as though they had been made by higher-priced draftsmen who know their business.

The checker should take nothing for granted, but should check and investigate everything. It is a great help in checking drawings to outline first a standard method of doing the work, jotting down special mistakes which are likely to occur, etc. It will probably be necessary to make changes in and additions to the outline, but when it is perfected it will undoubtedly add greatly to the speed and effectiveness of checking. In checking drawings, the check list given below will be found convenient. It may be reviewed to see if all matters have been considered.

CHECK LIST

- Anchors
- Arrangement of drawings
- Bar spacing
- Beams and girders:
  - area of steel
  - bent bars
  - bearing
  - bill of material
  - brackets
  - compressive steel
  - continuity steel
  - dimensions
  - fireproofing
  - length of beam
  - length of steel
  - lettering of
  - schedule
  - shear
  - spacing of steel
  - stirrups
  - tee section
  - web reinforcement
- Bearing of bars
- Bearing walls
- Bending diagrams
- Bending schedules
- Bill of material
- Bond of reinforcement
- Clearness of details
- Columns
  - area of steel
  - bill of material
  - compression
  - dimensions
  - fireproofing
  - future connections
  - height of
  - hooping
  - lap of bars
  - location
  - number of stays
  - numbering of
  - schedule
  - spirals
- Continuity bars
- Contract number
- Cross-sections
- Dimensions
- Drawing number
- Elevations
- Explanatory notes
- Footings:
  - bill of material
  - dimensions
  - dowels
  - elevation
- Footings:
  - length of bars
  - number of bars
  - schedule
  - spacing of bars
- Girders, see Beams
- Lap of bars
- Length of bars
- Lettering
- Openings
- Reinforcement
- Schedules
- Sections
- Shear on concrete
- Shop marks on bent bars
- Size of bars
- Slabs:
  - area of steel
  - anchor bars
  - bearing
  - bent bars
  - bill of material
  - continuity steel
  - fireproofing
  - length of bars
  - spacing of bars
  - temperature bars
  - thickness
- Spacing of
  - beams
  - columns
  - reinforcement
  - stirrups
- Special reinforcement
- Splicing of reinforcement
- Structural steel connections
- Temperature bars
- Tee Beams, see Beams
- Tile and joint construction
  - see also, Beams
  - size of tiles
  - spacing of joists
  - thickness of concrete covering
  - thickness of floor
- Title of drawing
- Views
- Walls
  - bill of material
  - height
  - length of bars
  - spacing of bars
  - thickness
- Width of Tee beams
- Working stresses

CORRECTING DRAWINGS—All drawings after being checked must be corrected at once, in preference to any other work. Look into all corrections carefully before doing any erasing. Do not erase the checker's marks. The draftsman must not simply take the checker's word for the proposed changes, but he must himself investigate the changes, and before any such changes are made the two must mutually agree. If changed without the draftsman's consent, then the drawing is really not checked at all. The proposed changes should be marked on the drawing with a

blue pencil. This color will not print, is easily seen and is easily cleaned off afterward with a spongy rubber or benzine if placed on tracing cloth. Proposed new figures should be placed far enough away from the existing ones, that the new figures will not be effaced when erasing the ink ones. The draftsman must leave all blue marks on the tracing, and return the same to the checker for his final approval.

ALTERATIONS—When tracings are altered in any way, the date of revision and the initials of the draftsman are to be marked on the tracing, thus: "Rev. 7/21/11. ERS."

HANDLING ORDERS

ORDERING MATERIAL—As soon as a contract has been secured and entered, complete data relating to the construction are turned over to the drafting department. Material should be ordered as soon as possible after the receipt of a job, using a few sizes and different lengths as practicable. The first thing to be done after the drawing has been checked is to prepare a list of the reinforcing material required, which is called a "material or order bill." The draftsman to whom this is entrusted should carefully take off the quantities from the drawing. Shipments to be made in accordance with the terms of the customer's order or contract.

MATERIAL BILLS—It is very important that all material be billed correctly on material bills, as all material is charged against the customer according to the material bills and all shipping is done according to these bills. The importance of avoiding errors and omissions in the material bills is apparent, since they may cause serious delay to the entire work. Care should, therefore, be taken to include everything in the material bill that will be required to properly reinforce the structure, unless upon inquiry from the squad boss that certain reinforcing steel may be ordered later.

It is usual to make material bills on printed forms, prepared just for this purpose. The forms are generally printed on thin strong paper that will admit of blueprinting. Sometimes the lists are written with a copying pencil or with hektograph ink.

The material bill should indicate the kind of material (medium or high carbon) and the specifications governing its quality and inspection.

SEPARATION OF SHIPMENTS—For a contract of any magnitude the material bills should be gotten out in sections; those parts which will be needed first should be gotten out first. Orders should be placed with respect to floors, and *each floor* separated, frequently it is necessary to split orders for shipment, and failing to place orders properly means delay.

In large structures, such as viaducts, long retaining walls, warehouses, factory buildings, etc., which are generally subdivided into shipments of suitable size, both straight and fabricated material bills must be made up separately for each shipment.

NUMBER OF COPIES—Make bills of material in duplicate. The original copy to be sent to the sales department and duplicate to be kept in the drafting room. Specifications for quality of steel must be noted on the first sheet of each order.

STRAIGHT MATERIAL BILLS—All material which is not fabricated should be listed on material bills marked "Straight Bars—No Fabrication," or words to like effect. List the smallest bars and shortest lengths first, keeping the rounds and squares separated.

FABRICATED MATERIAL BILLS—All material which is to be fabricated should be listed on sheets marked "Bars for Fabrication." All fabricated material bills must have on them the company's shop mark and where so required, the customer's mark.

One set of blueprints or copy must be made of all fabricated-material details and sent to the sales department. If necessary, other sets of prints may be made as required.

NUMBERING BILLS OF MATERIAL—All bills should be numbered consecutively, whether straight or fabricated and should show the number of the drawing to which they refer.

Where material bills are canceled, give revised material bills a new number.

MISCELLANEOUS

CARE OF DRAWINGS—Drawings at all times should be kept neat and orderly. They should be protected from chance of injury, both during the day and night. All tracings should be covered before leaving work with a heavy cloth or a piece of table oilcloth. This applies to drawings actually being worked upon and all tracings used in connection with the work. Never fold a drawing or tracing.

It is absolutely essential that the drafting room be kept in business-like order. All architect's and engineer's drawings should be filed when no longer needed. Do not allow old drawings to accumulate around the room.

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COST OF DRAWINGS—There is always a noticeable decrease in the cost of the details or working drawings when the plans for the reinforcement are made and designed by an engineer, either independently or associated with the architect, and separated from the general architectural plans. In comparing the cost of designing the reinforcement and making the drawings from the engineer's or architect's plans, the cost of the former is on an average of about 25% higher than the latter. Where the architect's plans are made with no dimensions, with only the outline and sections given, it being necessary to refer to the general plans for the location and dimensions, there is no saving of time, and the detailing runs as high as on the architect's plans.

The cost of reinforced-concrete details depends on so many things that it is hard to set any fixed rule for determining what this cost is. The type of the building is the first consideration; then the architect and engineer, their methods of drawing up their plans; and finally the detailing drafting force one is obliged to depend upon.

A Supply of Coal Tar for road-building purposes, to be recovered from coke-oven gases, is advocated by Mr. Prévost Hubbard, until recently chemist of the U. S. Office of Public Roads, in Circular No. 97 of that bureau. This circular states that out of 26,000,000 tons of coke produced in 1908, only 4,000,000 tons were obtained from byproduct ovens with recovery of tar; the average yield of coke per ton of coal was 66%, and this is taken to indicate the consumption of 33,000,000 tons of coal. A yield of 10 gal. of tar from a ton of coal is assumed as the basis of a statement that 330,000,000 gal. of tar was thus lost in 1908 which might have been recovered. The actual production of coal tar from coke oven and gas works in that year was about 101,000,000 gal., from which the inference is drawn that three-quarters of the possible production of tar was lost.

A Movable Roller Dam of the type first used at Schweinfurt, Bavaria (Engineering News, Jan. 19, 1905, p. 57) is to be installed by the U. S. Reclamation Service at the Boise River diversion dam in Idaho. In the construction of this dam it was necessary to leave an opening 30 ft. in width and 6 ft. in depth for the passage of logs to be used at the Barberton mill on the river below. Experience has shown that a movable dam of some kind to close this opening during long periods when the logway is not used would result in considerable saving of water. After careful study the roller type was selected, and an order has been placed with the German manufacturers, Maschinenfabrik Augsburg-Nürnberg, A. G., Gustavsberg bei Mainz, for a steel cylinder 32 ft. long and 6 ft. in diameter, and the necessary operating machinery. This dam is a patented construction and the German installations above referred to have proved it to be easily operated and efficient. It consists of a cylinder, made of heavy steel plates riveted together, equipped at each end with a toothed wheel which meshes with an inclined rack built in each abutment, and is operated by rolling it up the incline when not in use. The Boise dam will be much smaller than the two German ones, which are 121.3 ft. long and 6.56 ft. in diameter, and 59 ft. long and 13.58 ft. in diameter, respectively. A dam of the same kind having a length of 140 ft. is soon to be installed near Spokane, Wash., by the Washington Water Power Co.

Concrete Column Foundation for a Building Over Coal Mine Workings

An unusual form of foundation was adopted recently in constructing a high-class residence in Pittsburg in a location where the ground was known to contain old coal-mine workings at some distance under the surface. Since a great part of the city is underlain by such old workings, the condition is not an exceptional one, but ordinarily no means for protection against possible future caving of the workings are thought necessary. In this instance, however, the workings were near the surface, and the owner preferred to protect himself by carrying the foundations through the workings into sound rock below. The following describes the case in brief:

In preparing for the construction of a residence for O. M. Reif, at Beacon St. and Shady Ave., in the Squirrel Hill district of Pittsburg, exploratory holes were drilled to determine the extent of undermining by coal workings. The workings were found at depths of 35 to 55 ft. below the surface, with shale and sandstone overlying. The workings did not seem to be open and free of débris, indicating that the roof had fallen in the past, and it was considered quite likely that future caving of the roof and possible surface subsidence was to be anticipated. The owner therefore planned to sink concrete columns through the overlying rock and the workings, footing them in the solid rock below, and to support the house on girders carried by these columns. The work was designed and executed in accordance with this plan by the Cummings Structural Concrete Co., of Pittsburg.

A ground plan of the building is shown in the accompanying sketch Fig. 1. The front east corner of the house was known to rest over a pillar in the mine, and it was thought unnecessary to provide a column at this corner. Six columns were distributed along the other sides, marked in Fig. 1 as Cols. 1 to 6. They are directly under the walls and under the middle partition, in such arrangement that the lower portions of the walls could, by forming them into reinforced-concrete girders, be made to support the entire structure of the building and transmit the load to the columns. The loads noted in Fig. 1 along the several walls give an idea of the nature of the problem. As appears there, the columns of the left side wall carry about 65 tons each, and the girder in this wall (41 ft. long) has to distribute the load of 130 tons to these two columns. The cantilever arrangement of the girders, obtained by setting the columns inward of the corners, affords a substantial reduction of the bending moments.

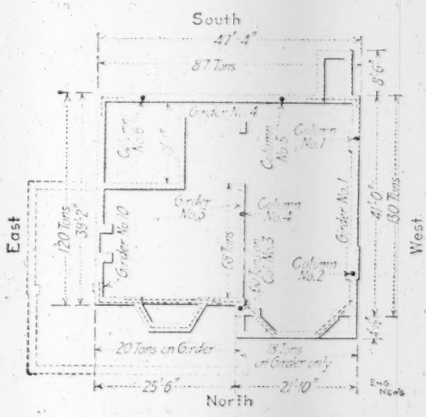

FIG. 1. GROUND PLAN OF REIF HOUSE, SHOWING LOCATION OF PILE COLUMNS AND REINFORCED-CONCRETE GIRDERS

The concrete was placed in 18-in. layers and churned to thorough compactness. Each column was concreted to the top in a single operation. The girders were concreted separately; it was required that the west and middle longitudinal girders and the rear transverse girder should each be concreted in one operation, and the small transverse girder under the front edge of the bay was concreted half with each of the adjoining longitudinal girders. On the east side and the east portion of the front wall, where no pile columns were placed, it was not thought necessary to use girders for support, but the lower part of the walls was reinforced for tie purposes.

The concrete for the columns was made in 1:2 proportion, using no stone. The girders were made of 1:2:4 gravel concrete. The tie girders at east side and front were made of 1:3:6 concrete.

Fig. 2 shows the essential features of one of the principal girders, that in the west wall, illustrating the general character of the construction.

It is of interest to note that the same problem arising about the same time in the case of another residence near by, the decision there was reached to support the building on reinforced-concrete girders resting directly on the ground, without columns.

The comparative merits of the two methods of treating the problem can only be determined after the possible subsidence has actually occurred.

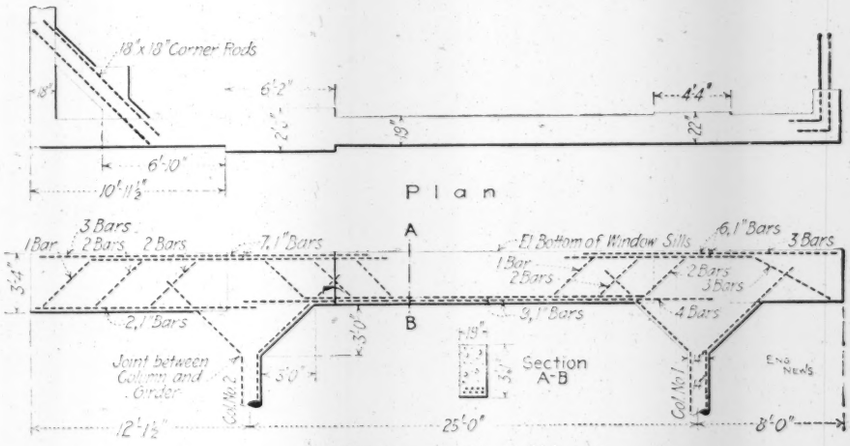

FIG. 2. WEST WALL GIRDER OF REIF HOUSE

The columns were formed by first drilling 10-in. and 14-in. holes down to the desired foundation level and then forming a reinforced-concrete column in the holes by inserting spiral reinforcement and filling the hole with concrete. The hole was lined by dropping in a galvanized-iron tube slightly smaller than the hole, this lining being continued to the surface; the object of this was to make the concrete columns completely independent of the rock and thus permit settlement of the rock without putting additional load on the columns.

The drilled holes, as already noted, are 10 in. and 14 in. in diameter, and the columns are 8 in. and 12 in. in diameter inside the galvanized-iron lining. The reinforcement in all cases consists of four 1-in. longitudinal rods and spiral hooping with 2-in. spacing of turns. The specifications required the hole to be cleaned thoroughly and the reinforcement to be placed so that the longitudinal rods bore solidly on the rock below. The concrete was placed in 18-in. layers and churned to thorough compactness. Each column was concreted to the top in a single operation. The girders were concreted separately; it was required that the west and middle longitudinal girders and the rear transverse girder should each be concreted in one operation, and the small transverse girder under the front edge of the bay was concreted half with each of the adjoining longitudinal girders. On the east side and the east portion of the front wall, where no pile columns were placed, it was not thought necessary to use girders for support, but the lower part of the walls was reinforced for tie purposes.

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Drinking Water in the Republic Mine of the Cambria Steel Co., Republic, Mich., is distributed by means of ½-in. galvanized-iron pipe and porcelain bubbling cups, according to a note by R. B. Wallace, in "The Engineering and Mining Journal" of Mar. 23, 1912. Pressure reducers are used at the lower levels and stop cocks are provided at intervals of 400 to 500 ft. for use in case of breaks in the pipe line. Sinks 1 ft. square placed beneath each cup and waste pipes lead from each sink to the mine-drainage system. The sink and the cup are attached to a vertically placed plank wedged between the floor and roof of the mine chamber. The supply pipe is brought along the roof and down the plank.

The Effect of the Strength-Increase in Concrete on the Stresses in an Overloaded Reinforced-Concrete Building

By Ernest McCullough*

The Building Commissioner of Chicago is compelling owners of buildings used for commercial purposes to placard the floors for safe loading, in accordance with the provisions of the new building ordinance. As a result of this ruling, the writer recently reported upon a reinforced-concrete building designed and erected in the year 1904. It was well designed and the original calculations of the designer had been preserved. Under the ordinance no allowance is made for the age of concrete, so the building, although seven years old, could not be certified for any higher floor loading than that for which it had been designed. In this particular instance two factors operated to make this a fair case and the ordinance worked no hardship, for the column footing had not been designed to permit the imposition of any greater loads, the columns had full cross-section considered as compression area and the reinforcement consisted of round plain bars of open-hearth medium steel. The owners, however, objected to the floor loading permitted, saying they understood that after concrete buildings had reached an age of five years the floor load could safely be doubled. The writer had to explain a number of items, not the least important of which was the question of adhesion and mechanical bond. The question of footing area they had evidence to show, as a result of an examination of neighboring buildings, was not of great importance; the loading permitted under the present ordinance is low for the character of soil, as compared with loadings formerly allowed and actually imposed. The cross-sectional area of the columns was not a matter of great importance, for if the concrete had increased 50% in strength during the past seven years the area within the rectangle inclosed by the reinforcing rods is amply sufficient, basing the original strength upon the present allowance for concrete under the age of 30 days. The fact that smooth round medium-steel bars had been used, alone prevented the owners from making a contest.

Within the past few months the Association of American Portland Cement Manufacturers has issued a book entitled "Factories and Warehouses of Concrete," intended for free distribution to prospective builders, with a view to advancing the cause of concrete construction. On p. 12 appears the following:

Reinforced concrete increases in strength with age. There are many tests of cement and concrete briquettes and cubes which demonstrate beyond controversy the increase in strength with time. Even if these tests were not available, anyone who made himself familiar with this type of construction would become convinced of the fact that concrete buildings are a great deal stronger than they were ever calculated to be. Poor workmanship and unusual conditions have sometimes occurred on buildings, but the material after once in position has always responded without a single sign of weakness. Concrete floors which have been designed for a strength of 200 lb. have been known to carry 500 and 600 lb., and floors which have been designed for loads of 600 lb. are carrying 1200 and 1500 without incurring the slightest deflection. The average owner of a concrete building after a few months of occupancy becomes so confident in the strength of his structure that he will overload to a degree which often brings forth a protest from his engineer or architect.

In another paragraph on the same page the author says:

An interesting commentary on the strength of concrete buildings is found in the latest practice in design which is becoming more and more prevalent. Advantage is taken of the increase in strength with time of a concrete building. If an owner desires a building to be four stories high, but to be built so as to carry later a fifth story, the columns are designed to carry the loads which will be brought on them if the building were to be ultimately only four stories high. At the end of a year or two these columns will have increased in strength to such an extent that a fifth story can be safely added, and the resulting loads on the columns will not produce stresses above the factor of safety used in the original design.

The foregoing quotations are given as a sample of the kind of argument that has been so potent in advancing the growth of the reinforced-concrete business. The man who is posted will see that the argument is presented by the manufacturer of cement and is absolutely true from his standpoint and when his product alone is considered. The total neglect of the important part that the steel plays in the composite material causes much trouble and is a fruitful source of accidents. That *the concrete* increases in strength with age is too well known to be controverted, but what of the steel? This point the writer believes he covered pretty thoroughly in his article in Engineering News, Jan. 4, 1912, so it is not necessary to again go over the points then discussed. Merely to enable readers of this article to understand the matter without having to refer to the one mentioned, it may be stated that the writer believes good design should take into consideration the strengthening effect of age upon concrete and the present tendency toward the use of high steel stresses should be fought, for the strength of the steel forever fixes the strength of the construction; so the increase in strength of the concrete is wasted. It does not increase the factor of safety appreciably, for a 50% increase in concrete strength merely lessens the steel stress about 2%. The proper combination of stresses may be fixed by the formula

$$f_c = \frac{f_s}{1.8\,n}$$

in which

f_c = Concrete fiber stress,
f_s = Steel fiber stress,
n = Ratio of deformation,

the above formula being original, so far as the writer is aware.

Limiting the designing stress in the steel to a maximum of 16,000 lb. per sq.in. and using a deformed bar, either of medium steel so deformed that the elastic limit is raised, or of a high elastic limit steel of first quality the ultimate safe stress may be 20,000 lb. per sq.in. by the time the concrete has increased not less than 50% in strength and the ratio of deformation is between 7 and 10. The design is made on the basis of a strength ratio as determined by the above formula with $n = 15$ for a 1:2:4 concrete. Using a value of $n = 8$ and $f_s = 20{,}000$, the total load which may be safely carried after the expiration of one year is ascertained. Deducting the weight of the construction we have the live load and in certain cases it will be found that the safe live load is doubled; quite an advantage for the owner and one which he is led to expect by such advertising as has been quoted.

Since steel stresses now commonly used are fixed by steel salesmen in very severe competition, the foregoing method of calculation has not been brought properly to the attention of owners. They have been told that the certain increase in the strength of the concrete will permit the addition of another story provided this has been taken into consideration in the design of footings. That the floors may be more heavily loaded, also as a result of the increase in concrete strength is taken for granted. Owners should be educated to understand that concrete costs more than steel and that undue economy in steel actually adds to the cost of the building and also permanently limits the load-carrying capacity of the floors. The neglected factor is the changing character of occupancy of buildings.

Safe live loads for residences and office buildings are seldom higher than 50 lb. per sq.ft. Observers of the growth of cities have noted that residence sections are gradually encroached upon by office buildings and as the city grows these office buildings are remodeled to some extent and adapted to light manufacturing and for carrying stocks of goods of manufacturers' agents. The end of many buildings comes when the district is finally given up to warehouse purposes and the failure of overloaded floors is common. It is well known that as build-

*Consulting Engineer, Monadnock Block, Chicago, Ill.

ings of ordinary construction become weak through age, the floor loads have a tendency to become greater and constant vigilance upon the part of the Building Department is required. If the laws can be strictly enforced as to the placarding of all floors and care is taken to see that no floors carry a heavier load than the placard indicates should not be exceeded, then many old buildings will be removed and good buildings erected in their stead. It is this fact which has caused the recent active work of the Building Commissioner of Chicago, his desire being to cause the removal of hundreds of buildings which are really in a dangerous state when used for other than rooming purposes, yet located where there is a temptation to use them for storage of merchandise.

Provided a high elastic limit deformed bar is used, a steel stress of 20,000 lb. per sq.in. may be finally attained and thus a building designed originally to carry a live load of 50 lb. per sq.ft. can, within less than two years be loaded to 100 lb. per sq.ft. and the still increasing toughening of the concrete relieves the stress on the steel. By careful design the weight of the construction can be so cut down that the live load may be more than doubled.

Engineers in private practice who are specializing in concrete work have a duty to perform toward their clients and the men who sell steel should coöperate with them, for the low stresses in steel used in the initial design should result in more steel being sold. At present the game is to try and work without the intermediary engineer, so the owner finally purchases his material direct and has a building erected which can be used for a certain load only for all time, without damage to the steel. If the average owner can be convinced that it is real economy to design for future increases in floor loadings, he will do so, for the difference in cost is very small. That owners do overload floors is shown in the matter quoted and for the protection of the material as well as the benefit of the owner, the men who sell cement should not fail to call attention to the fact that the increased strength of the concrete cannot be made available unless steel is provided to balance it. The dealers in the two materials entering into reinforced concrete do not, as yet, work well enough together and the private practitioner has not been treated kindly by either, the owner therefore being deprived of the advantage of disinterested advice. This neglected factor, which recognizes the changing character of occupancy, should be given the importance it deserves.

The Remodeling of Delhi, the new capital of India, is to be undertaken at once. To coöperate in this work the city of Liverpool, England, has given a five months' leave of absence to its city engineer, John A. Brodie, one of the leading municipal engineers of Great Britain.

Two Novelties in Aerial Tramway Construction

The aërial tramway as a means of transportation has been most largely used in mining operations for handling ores, coal, etc., and materials used in the mines. There are great opportunities, however, for its development and application in connection with manufacturing plants. In such locations it has the great advantage that the line is overhead, where it does not obstruct any operations on the surface of the ground and where the transmission of materials by it can be continuous without such interruptions as sometimes occur from blockades, etc., on railway tracks laid on the ground.

The reliability of well designed aërial tramways to safely carry their loads is well illustrated by the fact that an aërial tramway has been in use for nearly 14 years at the works of the American Optical Co., at Southbridge, Mass., where it has been used to carry large cases of spectacle lenses from one part of the works to another. This line was 1700 ft. in length and carried loads varying from 250 to 500 lb., dispatched at intervals of about five minutes.

A recent radical enlargement of the plant and change in the method of conducting the work made this tramway no longer necessary, and it was dismantled. A new line has, however, been built which serves at once for a conveying system and for hoisting. This line is 495 ft. long and is of the reversible type, with a single-track cable and a traction rope. Only one carrier is used with this line, and it has a receptacle of 420 lb. capacity. This carrier is moved from one terminal station to the other and returned along the same track cable by reversing the motion of the traction type. The traction rope is driven by a small electric motor; the power required is insignificant. One terminal station of the tramway is on the roof of the building where the lenses are ground. When the carrier arrives at this station, it runs off the horizontal track cable and is lowered vertically a distance of 36 ft. suspended by the same traction rope that hauls it along the horizontal run. The traction rope is, of course, permanently attached to the carriage which constitutes the connecting link of an endless circuit, and the proper tension in the rope is maintained by a counterweight attached to a fall-block, which rises as the carrier is lowered and drops when the carrier is raised. When the carrier reaches its lowest position, an automatic switch shuts off the electric current and brings the carrier to a stop.

This novel feature in aërial tramway construction may often be adopted to advantage when it is desired to deliver materials at a terminal on a much lower level than that at which the tramway operates. That such hoisting and conveying may be done with perfect safety and security, moreover, is evident by the fact that such delicate and very valuable materials as spectacle lenses are so carried in the installation above described.

The other device referred to has been installed in two aërial tramways, which have been built for the E. I. du Pont de Nemours Powder Co. for the conveyance of cans of "dope" used in the manufacture of dynamite, which have to be delivered at certain intervals to a series of mixing houses located some distance apart. Each carrier holds four cans, making a total load of about 600 lb. These carriers are dispatched at intervals of four minutes, or a total of 9000 lb. an hour, and a system has been worked out whereby a carrier can be switched off automatically at any one of the mixing houses without stopping the traction rope or without impeding the travel of other carriers moving over the line.

At each mixing house there is an overhead rail turnout, controlled by switches which are operated by means of compressed air. Each carrier is provided with a vertical sliding rod, indented with notches at the top which engage a spring latch and is capped with a short arm. This rod is set in a certain position by means of an indicating piece termed a "selector," so as to engage a slightly inclined hinged plate or flat bar at the turnout where the carrier is to be switched off. When this plate is struck, it opens a valve in a compressed-air pipe which actuates the switch and at the same time it releases the grip from the traction rope. This system has been in operation now for over three years and has been proved thoroughly reliable.

During the past five years the E. I. du Pont de Nemours Co. has installed at its various works in the United States five cable tramways and nine overhead rail tramways of specal construction for the conveyance of materials at its various powder works. All the tramways here described have been installed by the Trenton Iron Co., of Trenton, N. J.

The Replacement of Horse Cabs by motor cabs in European cities is now so complete that in Berlin, Germany, the horse cabs are to be forbidden the use of the streets. The Berlin Chief of Police has issued an order stating that as horse cabs are so nearly obsolete they can no longer be allowed to circulate in the city streets after Mar. 31. To compensate the drivers of these cabs for their loss of employment, each is to receive compensation to the amount of 600 marks and encouraged to learn to drive motor cabs. In London the deterioration of horse-cab service under competition of motor cabs is such that a committee is being formed for the relief of indigent cab drivers and the prevention of the use of unfit horses.

Bursting Tests of Steel Flasks for Compressed Gases

By G. A. Bisset*

An investigation was instituted by the U. S. Navy several years ago to determine the specifications of a steel that, when worked into a flask such as is used for storing compressed gases on board naval vessels, could be depended upon under all circumstances not to shatter or burst with a bomb effect. Air under high pressure let loose in a small compartment would be sufficiently dangerous without any flying fragments of steel.

As a result of the investigation specifications were prepared reading about as follows. A few changes have been made as a result of recent observations to bring the specifications quoted up to date:

Seamless Steel Flasks for Compressed Air

Standard Sizes and Pressure—Flasks will, unless special conditions otherwise require, be made in two standard sizes, viz., 10 in. and 16 in. inside diameter. The outside diameter shall not vary more than $\frac{1}{8}$ in. nor the length more than $\frac{1}{16}$ in. from that specified. The two sizes are to be in accordance with the attached sketch [The sketch, not produced here for lack of space, shows a thickness of 0.57 in. for the 16-in. flask and 0.35 in. for the 10-in. flask.—Ed.], and in lengths as ordered. Unless otherwise specified, flasks are to be designed for a pressure of 2500 lb. per sq.in. In case diameter or pressures other than those specified above are used, the thickness of the flask is to be not less than that determined by the following formula:

$$D \times 2P = 2 \times T \times 70{,}000.$$

In which D = inside diameter of flask in inches, P = working pressure in lb. per sq.in. (normal pressure of air to be stored); T = thickness of flask in inches.

The thickness of flask must nowhere be less than T, as determined above, nor must the wall thickness of the cylindrical part exceed, at any point, 1.2 T. The thickness of metal of flask neck at bottom of thread must not be less than the wall thickness. Weight of flask must be such as to indicate no excessive thickness.

Material and Process—Seamless flasks for compressed air are to be made from solid plate disks of chrome-vanadium steel* by the process known as "hot-drawing." As the drawing of the flasks is completed and they are ready for swaging they are to be inspected inside and outside for surface defects. After swaging, the flasks are to be pickled to facilitate a second surface inspection. Before threading the necks, all laps due to wrinkling or crimping must be removed by machining.

Identification—The material from which the flasks are to be made is to be inspected at the rolling mill for surface defects. Each plate, if satisfactory, is to be stamped for identification.

Tensile Tests—From each flask two rings shall be taken at the time flasks are cut to lengths for swaging, one ring for tensile and one for bending tests, both specimens to be subjected to the same heat treatment that the flasks receive. The tensile specimen is to be opened out flat at a low red heat and prepared as a standard 8-in. tensile-test specimen. It must have an elastic limit of not less than 90,000 lb. per sq.in. and a tensile strength of not less than 110,000 lb. per sq.in.

Bending Test—The rings taken as described above must stand bending cold through 180° to a diameter equal to four times the thickness of the ring without showing fracture. Ring may be cut before this test.

Hydrostatic-Pressure Test—When completed each flask is to be tested to a hydrostatic pressure equal to twice the required working pressure without showing rupture or permanent set exceeding 5% of the volumetric expansion. During this test the flask will be inclosed in a water jacket to permit the expansion to be readily noted.

Surface and Other Defects—The flasks must be free from surface and other defects liable to affect their value.

The first lot of flasks ordered under the new specifications has been completed. The manufacture of this first lot involved quite a little speculation and experimenting with a view of ascertaining the heat treatment that would give the best results. Three flasks were tested to destruction, that is until they burst, in order that the effects of the different heat treatments might be observed.

TABLE I. PHYSICAL TESTS

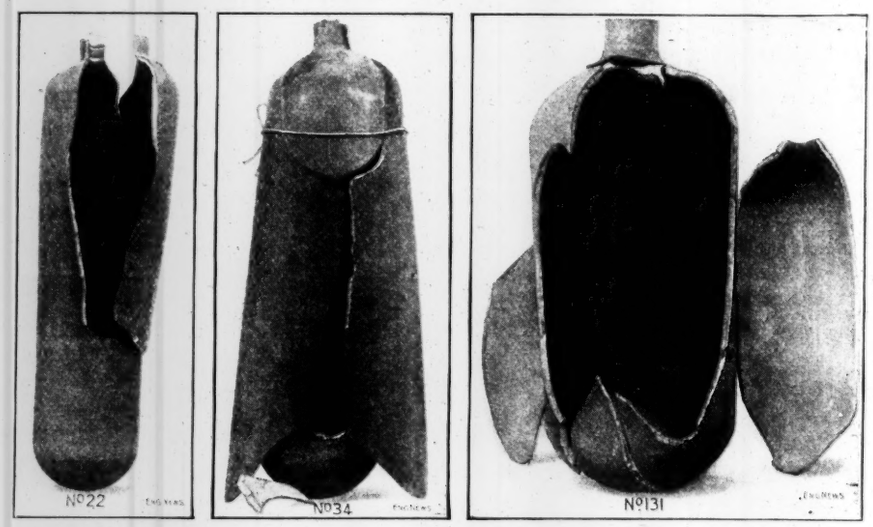
Cylinder number	Elastic limit	Tensile strength	Elongation in 8 in.	Reduction of area
22.....	134,280	150,150	5%	37.3%
34.....	115,800	138,700	7.7%	32.9%
131.....	120,260	136,700	7%	39.6%

The physical and hydrostatic tests of the flasks gave the results shown in Table I.

Two of the flasks, as shown in Table II, were tested to the required hydrostatic test pressure of 5000 lb. per sq.in., with the result as indicated.

In the bursting test, the flask was first filled with air under a pressure of 400 lb. per sq.in. Water was then forced into the flask until it burst, the bursting pressure being as recorded in the table. The object of having air in the flask was to simulate, as nearly as possible, service conditions. It was considered that air under high pressure would have a much greater shattering effect than water. It is believed that the tests give a fair indication of the shattering to be expected in case of the explosion of a flask on a naval vessel.

The accompanying illustration shows the flasks after the test. It was expected that flask No. 22, quenched at 1600° F. and annealed to 900°, would give a higher bursting pressure and shatter more than flask No. 34, which was quenched at 1600° F. and annealed to 1200°. By annealing to 1200° instead of 900° the temper would be drawn more, softening the metal. This, it was expected, would



Chrome-Vanadium Steel Cylinders Burst by Air Pressure of 10,000 to 14,000 lb. Per Sq.in. in Tests at McKeesport, Penn.

ABTLE II. HYDROSTATIC AND BURSTING TESTS

Cylinder No.	Diameter in inches Outside	Inside	Length	Test pressure, lb. per sq.in.	Expansion, cu.in.	Permanent set Cu.in.	Per cent.	Bursting pressure, lb. per sq.in.
22	13⅜	12⅝	5 ft. 1 in.	5000	26.5	0.3	1.1	10,000
34	13⅜	12⅝	4 ft. 11 in.	5000	24.5	0.3	1.2	14,000
131	15⅞	12⅝	2 ft. 11 in.	no hydrostatic test made				13,500

HEAT TREATMENT—Cylinder No. 22 quenched at 1600° F. and annealed to 900° F. Cylinder No. 34 quenched at 1600° F. and annealed to 1200° F. Cylinder No. 131 quenched at 1600° F. and annealed to 1200° F.

*Naval Constructor, U. S. N., Office of Inspector of Hull Material, Carnegie Steel Works, Munhall, Penn.

*This material differs from special-treatment steel plating in that there is no nickel present, and the chromium content is less.

reduce the bursting pressure and decrease the shattering propensities.

Just the reverse of the expected happened, however, and the fact that flask No. 131 agreed practically with flask No. 34 and shattered to about the same extent indicates that the result was not accidental. Other tests have been made with softer steel having a tensile strength of about 60,000 lb., but this material, entirely contrary to theory, shattered worse than any other tried.

Effect of Water Meters in Reducing Water Waste at Decatur, Ill.*

By F. H. Ruthrauff†

As to the effect of installing water meters at Decatur, Ill., I simply state the facts as I have found them during my 22 years' experience in the Water Department in Decatur.

The first five years I served as water inspector and worked faithfully in an effort to stop the waste, which was enormous, due to carelessness on the part of the consumers and to defective plumbing. In 1896 I employed four assistants, with the avowed intention of stopping all leaks. I again went over the city in 1898 with four assistants. I had citizens by the score brought into our police courts and prosecuted them for willful waste.

After about five years' labor along this line I began to get discouraged. I found that a great many of our citizens believed we had an inexhaustible supply of water, and could not see any good reason why I should be so extremely anxious about this matter.

Consequently, I began to look for some other plan, believing that if this waste were allowed to continue, taking into consideration our rapid increase in population, we would in a short time find our supply short, or be at an unnecessary expense for additional machinery, mains and enlargement of our reservoir and filter plant in handling water merely to be wasted.

In 1901, I recommended to the council the adoption of the water meter on all services, but no action was taken. Again in 1902 I urgently recommended the same plan, and was then ordered to have all livery stables, hotels and laundries install meters. In the spring of 1908, the council ordered all services metered by July 1, 1908. The results are as follows:

Apr. 31, 1904, the end of our fiscal year, we had 2112 services recorded; five consumers for each service gave us 10,560 consumers; 987 of these services were metered. (There was no record kept of water pumped prior to 1903.) However, with 10,560 consumers, 4935 of them metered, there was pumped for this year 1,023,463,180 gal., which gave us a per capita consumption of 266 gal.

For the fiscal year ending Apr. 31, 1911, we had 4939 services in use; 4933 of them being metered. (The six services unmetered are large consumers.) This gives us, on a basis of five consumers to the service, 24,695 consumers. There was pumped during this year 1,124,212,338 gal., which is 100,749,158 gal. in excess of that for 1904.

With an addition of 14,135 consumers, we now have a per capita consumption of less than 125 gal. (as against 266 gal. in 1904). It is my belief that if the six consumers previously mentioned were metered, this consumption would be less than 100 gal.

We have accomplished by the enforced use of meters at least a 30% reduction in the average householder's bill. Under the old flat-rate system a seven-room modern house would cost him $17 per year, and under our present system the yearly bill should not exceed $12. We have also cut the per capita consumption from 265 gal. to 125 gal., saving an unnecessary pumpage of 1,270,928,175 gal. each year.

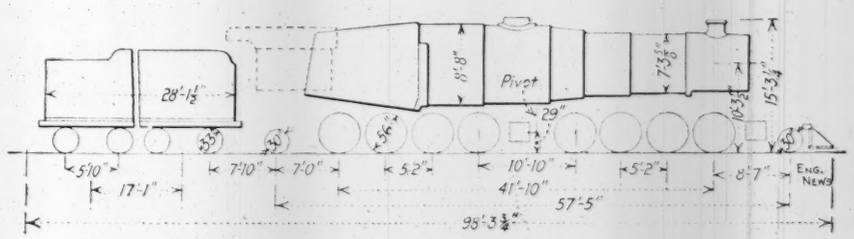
*Abstract of a paper read at the annual meeting of the Illinois Water Supply Association, at Urbana, Ill., Mar. 5-6.

†Water Inspector, Decatur, Ill.

The Concrete Arch of 420-ft. Span which was proposed for the new Bloomfield bridge at Pittsburg, Penn., has been disapproved by the Finance Committee of the City Council, and as a result it is expected that this bridge will be built of steel. An appropriation of $500,000 had been made for this bridge, but the director of the Public Works Department recently introduced to the Council an ordinance calling for an additional $275,000, which was to be added to the cost of the Bloomfield bridge on account of a change in its design from steel to concrete. The total length of the bridge which was proposed to be built of concrete was to have been 1970 ft. This was to include one single arch, 420 ft. in span (about 92 ft. longer than the present longest concrete arch), and several 190-ft. spans with the remainder of the structure made up of 30-ft. spans. The consulting engineer, Emil Swensson, advised the Council against the concrete bridge on the ground that a steel bridge would be sufficient to answer the purpose and could be built within the original $500,000 appropriation. His recommendation was accepted by the Council and the additional $275,000 appropriation killed.

Mallet Simple Locomotive: Pennsylvania R.R.

A new development in the Mallet duplex type of locomotive is seen in an engine built recently for the Pennsylvania R.R., in which the usual compound arrangement is abandoned and all the four cylinders take high-pressure steam. The reason for this is that for the power required, the low-pressure cylinders of a compound engine would have been so large as to foul the clearance lines. The boiler pressure is unusually low, being only 160 lb. The engine is of the 2:8:8:2 class, and is being tried for heavy freight service for the steep grades of western Pennsylvania. The engine was built by the American Locomotive Co., but is somewhat experimental, in order to see what modifications may be necessary if the general type should be adopted. The general dimensions of the engine are as follows:



General Design of Mallet Simple Locomotive (2:8:8:2) for the Pennsylvania R.R.; All Cylinders 27x28 In.

DIMENSIONS OF MALLET SIMPLE LOCOMOTIVE: PENNSYLVANIA R.R.

Driving wheels, 16 (8 in each group)	4 ft. 8 in.
Truck wheels, 4 (2 each end)	2 ft. 6 in.
Tender wheels, 8	2 ft. 9 in.
Wheelbase, driving (each group)	15 ft. 6 in.
Total	41 ft. 10 in.
Total engine	57 ft. 5 in.
Tender	22 ft. 11 in.
Engine and tender	88 ft. 2 in.
Truck axle to first driv. axle	8 ft. 7 in.
Truck axle to last driv. axle	7 ft. 0 in.
Length over pilot and tender coupler	98 ft. 3¾ in.
Weight in working order:	
Front drivers	216,500 lb.
Rear drivers	221,000 lb.
Total on drivers	437,500 lb.
Max. axle load; front, 56,000; rear	63,000 lb.
On each truck	22,500 lb.
Engine, total (empty, 425,700)	482,500 lb.
Tender, loaded	186,400 lb.
Cylinders, four	27x28 in.
Spacing, c. to c.	7 ft. 2 in.
Width over cylinders	10 ft. 4 in.
Boiler, diameter	7 ft. 3⅝ in. to 8 ft. 8 in.
Rail to center line	10 ft. 3½ in.
Working pressure	160 lb.
Firebox	12x8 ft.
Tubes; No. 282; diameter	2¼ in.
Length over tube plates	24 ft. 8 in.
Heating surface; tubes	5717 sq.ft.
Firebox	404 sq.ft.
Superheater tubes	1602 sq.ft.
Total	7723 sq.ft.
Smokestack, height above rail	15 ft. 3¾ in.
Water in tender	9000 gal.
Coal in tender	15 tons

The Progress of the Commission Plan of City Government to Jan. 1, 1912

Two hundred cities of the United States had adopted the commission plan of city government up to Jan. 1, 1912, according to the table which we present herewith. This fact becomes all the more notable when it is stated that the adoption of the commission plan was scarcely more than begun until 1909.

As many of our readers know, the commission plan, as now understood, was first adopted at Galveston, Tex., in 1901, to meet the situation caused by the Galveston flood of the previous year, with which situation the old city government seems to have been unable to cope.

The plan was tried four years before a second Texas city (Houston, in 1905) adopted it. No city adopted the plan in 1906, but during 1907 it was given a start ahead through its adoption by Des Moines, Ia., and eight other cities, the majority of which, as might be expected, were in Texas. The year 1908 saw only six cities added to the list, but in 1909 there were 29; in 1910, 58; while in 1911 the table shows 95 more additions. These yearly figures, combined with seven cities with unknown dates of adoption, bring the total up to 206, at the close of 1911. The figures, however, are subject to revision. Their origin is stated in a foot note to our large table. It should be added that the table was compiled for "The International Year Book," issue of 1911, by a member of the editorial staff of this journal, and is here printed by permission.

The accompanying smaller table (II) shows the distribution of commission

TABLE II. GEOGRAPHICAL DISTRIBUTION OF COMMISSION PLAN CITIES, JAN. 1, 1912

Maine	1	Ohio	...
New Hampshire	0	Indiana	...
Vermont	0	Michigan	7
Massachusetts	6	Illinois	19
Rhode Island	0	Wisconsin	3
Connecticut	0		
New England	7	N. Central	29
New York	0	Iowa	7
New Jersey	7	Minnesota	3
Pennsylvania	0	Kansas	26
Delaware	0	Nebraska	2
Maryland	1	South Dakota	3
		North Dakota	11
Middle	8	Wyoming	1
		Montana	1
		Northwestern	54
Virginia	0	Missouri	...
West Virginia	3	Arkansas	...
North Carolina	3	Texas	29
South Carolina	1	Oklahoma	17
Georgia	2	Colorado	3
Florida	2	New Mexico	1
Southern	11	Southwestern	50
Alabama	8	Washington	8
Mississippi	4	Oregon	1
Louisiana	1	California	12
Tennessee	5	Arizona	...
Kentucky	2	Nevada	...
		Utah	5
S. Central	20	Idaho	2
		Pacific & Rocky Mt.	28
		Total	206

TABLE I. COMMISSION PLAN CITIES TO JANUARY, 1912[1]

Authority[2]	Place	Date voted[3]	Date in effect	Population, 1910[4]
	Maine			
S L	Gardiner	1911	.....	5,311
	Massachusetts			
S L B	*Gloucester	1908	.....	24,398
S L B	*Haverhill	1908	....	44,115
S L	*Lawrence	1911	....	85,892
S L B	*Lynn	1911	.....	106,294
S L	*Taunton	1909	....	89,336
	New Jersey			
L B	†Hawthorne	1911	1911	3,400
L	†Irvington	1911	1911	11,877
L B	†Margate City	1911	1911	129
S L	†Ocean City	1911	1911	1,950
S L B	†Passaic	1911	1911	54,773
L	†Ridgewood	1911	1911	5,416
S L B	†Trenton	1911	1911	96,815
	Maryland			
S L B	Cumberland	1910	1910	21,839
	West Virginia			
S L B	*Bluefield	1909	1909	11,188
S L B	*Huntington	1909	1909	31,161
S L B	*Parkersburg	1911	1911	17,842
	North Carolina			
S L B	*Greensboro	1911	1911	15,895
S L B	*High Point	1909	1909	9,525
S L B	*Wilmington	1911	1911	25,748
	South Carolina			
S L B	†Columbia	1910	1910	26,319
	Georgia			
S L	†Cartersville	1911	....	4,067
L	Marietta	1911	....	5,949
	Florida			
L	Green Cove Springs	1911 (?)	....	1,319
L	Passagrille	1911 (?)	....	not given
	Alabama			
S L B	†Birmingham	1911	1911	132,685
L	†Cordova	1911	....	1,747
S L	†Hartsell	1911	....	1,374
S L B	†Huntsville	1911	....	7,611
S L B	†Mobile	1911	....	51,521
S L B	†Montgomery	1911	1911	38,136
S L	†Talladega	1911	....	5,854
S L	†Tuscaloosa	1911	....	8,407
	Mississippi			
S L B	†Clarksdale	1910	1911	4,079
S L	†Gulfport	1911	....	6,386
S L B	†Hattiesburg	1910	1911	11,733
S	†Laurel	1911 (?)	....	8,465
	Louisiana			
S L B	†Shreveport	1910	1910	28,015
	Tennessee			
S L B	*Chattanooga	1911	....	44 604,
L	Etowah		....	1,685
S L	*Knoxville	1911	1912	36,346
S L B	*Memphis	1909	1910	131,105
L	*St. Elmo	1911	1911	2,426
	Kentucky			
S L	Lexington	1911	1912	35,099
S L B	†Newport	1910	....	30,309
	Michigan			
L	‡East Jordan	1911	....	2,516
L	‡Flint		....	38,550
S L	Fremont	1911	.....	2,009
S L B	‡Harbor Beach	1910	1910	1,556
S L B	‡Pontiac	1911	1911	14,532
S L B	*Port Huron	1910	1911	18,863
S L B	Wyandotte	1911	1911	8,287
	Illinois			
L	‡Braceville	1911	1911	971
S L B	†Carbondale	1911	1911	5,411
	Illinois, continued			
S L B	†Clinton	1911	1911	5,165
S L B	†Decatur	1911	1911	31,140
S L B	†Dixon	1911	1911	7,216
S L B	†Elgin	1911	1911	25,976
S L	†Forest Park	1911	1911	6,594
S L	†Hamilton	1911	1911	1,627
S L B	†Hillsboro	1911	1911	3,424
S L B	†Jacksonville	1911	1911	15,326
S L B	†Kewanee	1911	1911	9,307
S L B	†Moline	1911	1911	24,199
S L B	†Ottawa	1911	1911	9,535
S L B	†Pekin	1911	1911	9,897
S L B	†Rochelle	1911	1911	2,732
S L B	†Rock Island	1911	1911	24,335
S L B	†Springfield	1911	1911	51,678
S L B	†Spring Valley	1911	1911	7,035
S L	†Waukegan	1911	1911	16,069
	Wisconsin			
S L B	†Appleton	1911	1911	16,773
S L B	†Eau Claire	1910	1910	18,310
S L	Oshkosh	1911	....	33,062
	Iowa			
S L B	†Burlington	1909	1910	24,324
S L B	†Cedar Rapids	1907	1908	32,811
S L B	†Des Moines	1907	1908	86,368
S L B	†Fort Dodge	1910	1911	15,543
S L B	†Keokuk	1909	1910	14,008
L B	†Marshalltown	1910	1911	13,374
S L B	†Sioux City	1910	1910	47,828
	Minnesota			
S L B	‡Faribault	1911	1911	9,001
S L B	‡Mankato	1910	1910	10,365
S L	St. Cloud	1911	....	10,600
	Kansas			
S L B	†Abilene	1910	1910	4,118
S L B	†Anthony	1909	1909	2,669
S L B	†Caldwell	1909	1909	2,205
S L	†Chanute	1911	....	9,272
L B	†Cherryvale	1910	1911	4,304
S L B	†Coffeyville	1909	1910	12,687
L B	Council Grove	1911	1911	2,545
S L B	Dodge City	1910	1911	3,214
S L B	†Emporia	1910	1910	9,058
S L B	†Eureka	1910	1910	2,333
S L B	†Girard	1910	1910	2,446
S L B	†Hutchinson	1909	1909	16,364
S L B	†Independence	1909	1909	10,480
S L B	†Iola	1910	1910	9,052
S L B	†Kansas City	1909	1910	82,331
S L B	†Leavenworth	1908	1908	19,363
S L	†Manhattan	1911	....	5,722
S L B	†Marion	1910	1910	1,811
S L B	†Neodosha	1910	1911	2,872
S L B	†Newton	1910	1910	7,862
S L B	†Parsons	1909	1910	12,463
S L B	†Pittsburg	1910	1910	14,755
S L	†Pratt	1911	....	3,302
S L B	†Topeka	1909	1910	43,684
S L B	†Wellington	1910	1910	7,034
S L B	†Wichita	1909	1909	52,450
	Nebraska			
S L	Beatrice	1911	....	9,359
S L	†Omaha	1911	....	124,096
	North Dakota			
S L B	†Bismarck	19 9	1909	5,443
S L B	†Mandan	1907	1907	3,873
S L B	†Minot	1909	1909	6,188
	South Dakota			
S L B	†Aberdeen	1911	1911	10,753
S	†Canton		....	2,103
S L B	†Chamberlain	1910	1910	1,275
S L B	†Dell Rapids	1910	1910	1,367
S L B	†Huron	1910	1910	5,791
S L	†Lead	1911	....	8,392
S L B	†Pierre	1910	1910	3,656
S L B	†Rapid City	1910	1910	3,854
S L B	†Sioux Falls	1908	1909	14,094

[1]This list is based primarily on one kindly supplied by the National Municipal League, which included for most of the places all the classes of information given in the table except the dates the plan went into operation. The league list was checked and slightly extended by a list of names of cities only, supplied by the Short Ballot Organization, which list was understood to include only such cities as comply with a fixed standard for commission government, as verified by correspondence or by study of charters or other statutes. Both the lists named had been revised to about Jan. 12, 1912. The table formed as thus far stated was further checked, some gaps in "Date voted" and "Charter or general law" columns filled and the "Date in effect" column added from one of the many detailed tables in Bradford's "Commission Government in American Cities," which tables appear to have been brought down to about the middle of 1911. The first or left-hand column of the accompanying table indicates which one, two or three of the authorities cited include the various cities in their list, but does not indicate what other of the information given is thus vouched for. As a rule, it will be noted that all three authorities list each city, except for cities reported as having adopted commission government in 1911.

[2]S = Short Ballot Organiaztion; L = National Municipal League; B = Bradford; all as explained in the preceding note.

[3]Date voted generally means the date of acceptance by the locality, by popular vote.

[4]By U. S. Census.

*Charter. †State La. ‡Home Rule Law. As a rule Charter means a state legislative grant, subject to local adoption by popular vote. Home Rule Charter means a charter framed by a popularly authorized local charter commission, instead of one passed by the state legislature. State Law means a general act, usually subject to adoption by any municipal corporation with the class or classes specified in the act.

Author-ity[2]	Place	Date voted[3]	Date in effect	Population, 1910[4]
	South Dakota, continued			
S L B	†Vermillion	1910	1910	2,187
S L B	†Yankton	1910	1910	3,787
	Wyoming			
S L B	Sheridan	1911	1912	8,408
	Montana			
S L B	†Missoula	1911	1911	12,869
	Texas			
B	†Abilene	1911	....	9,204
S L B	†Aransas Pass	1910	1910	1,197
S L B	*Austin	1909	1909	29,860
L B	†Barry	1910	1910	not given
S L	Beaumont	.....	....	20,640
S L B	*Corpus Christi	1909	1909	8,222
S L B	*Dallas	1907	1907	92,104
S L B	*Denison	1907	1907	13,632
L B	†Elkhart	1910	1910	not given
L B	†El Paso	1907	1907	39,279
S L B	†Ft. Worth	1907	1907	73,312
S L B	†Galveston	1901	1901	36,981
S L B	†Greenville	1907	1907	8,850
L B	Harlingen	1910	1910	not given
S L B	*Houston	1905	1905	78,800
S L B	†Kennedy	1910	1910	1,147
L B	†Lyford	1910	1910	not given
B	†McAllen	1911	1911	not given
S B	†Marble Falls	1910	1910	1,061
S L B	*Marshall	1909	1909	11,452
L	Orange	.....	....	5,527
S L B	*Palestine	1909	1909	10,482
S L	Port Arthur	1911	....	7,663
S L B	†Port Lavaca	1910¶	1909¶	1,699
B	†San Benito	1911	1911	not given
L B	Spur	1911	....	not given
L	Sherman	....	....	12,412
B	†Terrell	1910	1911	7,050
L B	*Waco	1909	1909	26,425
	Oklahoma			
S L B	‡Ardmore	1908	1909	8,618
S L B	‡Bartlesville	1910	1910	6,181
S L B	‡Duncan	1910	1910	2,477
S L B	‡Enid	1909	1909	13,799
S L B	‡El Reno	1910	1911	7,872
S L B	‡Guthrie	1911	1911	11,654
S L	‡Holdenville	1911	....	2,296
S L	‡Lawton	1911	....	7,788
S L B	‡McAlester	1910	1910	12,954
S L B	‡Miami	1910	1910	2,907
S L B	‡Muskogee	1910	1911	25,278
S L B	‡Oklahoma City	1911	1911	64,205
S L B	‡Purcell	1910	1911	2,740
S L P	‡Sapulpa	1910	1910	8,283
L	‡Stillwater	1911	....	3,444
S L B	‡Tulsa	1908	1909	18,182
S L B	‡Wagoner	1910	1911	4,018
	Colorado			
S L B	‡Colorado Springs	1909	1909	29,078
L B	‡Grand Junction	1909	1909	7,754
L	‡Pueblo	1911	....	44,395
	New Mexico			
S L	†Roswell	1910	....	6,172
	Washington			
S L	Centralia	1911 (?)	....	7,311
S L	Chehalis	1911	....	4,307
S L B	†Hoquiam	1911	1911	8,171
S L	North Yakima	1911	....	14,082
L	Olathe	1911	(No such post	3,000
S L B	‡Spokane	1910	1911	104,402
S L B	‡Tacoma	1909	1910	83,743
S L	‡Walla Walla	1911	....	19,364
	Oregon			
S L B	‡Baker City	1910	1910	6,742
	California			
S L B	‡Berkeley	1909	1909	40,434
S L B	‡Modesto	1910	1911	4,034
S L B	‡Monterey	1910	1911	4,923
S L B	‡Oakland	1910	1911	150,174
B	‡Pomona	1911	1911	10,207
L	‡Riverside	.....	....	15,212
S L	‡Sacramento	1911	....	44,696
S L B	‡San Diego	1909	1909	39,578
S L B	‡San Luis Obispo	1910	1911	5,157
S L B	‡Santa Cruz	1911	1911	11,146
S L	‡Stockton	1911	....	23,253
S L	‡Vallejo	1911	1911	11,340
	Utah			
S L B	†Logan	1911	....	7,522
S L B	†Murray	1911	....	4,057
S L B	†Ogden	1911	....	25,580
S L B	†Provo	1911	....	8,925
S L B	†Salt Lake City	1911	....	92,777
	Idaho			
L	Boise	.....	.....	17,358
S L B	*Lewiston	1907	1907	6,043

*Charter. †State law. ‡Home rule law.
¶So given by Bradford. [4]By U. S. Census.

cities by states and groups of states. There are commission cities in every one of the eight groups of states, and in 34 of the 48 states. Of groups, the northwestern leads with 54 commission cities, but the southwestern group is a close second, with 50. New England, with seven cities, tails the list, but is only one behind the eight of the Middle states. Texas with 29, Kansas with 26 and Oklahoma with 19 lead the several states.

Abstracts of Reports of the American Railway Engineering Association

Tunnel Ventilation*

On the question of tunnel ventilation, no definite conclusion has been reached, but the committee leans to a belief that artificial ventilation is usually unnecessary in American steam-railway tunnels of less length than 2000 to 2500 ft., and that probably the most efficient form of artificial ventilation for American steam-railway tunnels is to force air into one end of the tunnel by fans powerful enough to drive the smoke out ahead of the train. This method was adopted for the Elkhorn tunnel on the Norfolk & Western Ry., and is admirably described by Chas. S. Churchill in the *Transactions* of the American Society of Civil Engineers (Vol. 54, part C). Plants similar to that constructed for the Elkhorn tunnel have been installed as shown by the record given in the accompanying table. The Baltimore & Ohio Ry. is now experimenting on single- and double-track tunnel ventilation, but the various methods used in the different tunnels are at such great variance that no conclusion has as yet been reached.

*From the report of the Committee on Roadway.

Switches and Frogs†

Length of Switch Rails — In determining the lengths of switches it is necessary to provide for the following general classes of turnouts: (A) Turnouts to be operated over the divergent route at the maximum practicable limited speed. (B) Main line turnouts and crossovers to be operated over the divergent route at low speed. (C) Yard turnouts. (D) Turnouts requiring frogs of large angle.

Another point considered was the economical cutting of a 33-ft. rail; and the question of using the full 33 ft. as one of the lengths of switch rail has been very fully discussed by the committee. The main objections to the use of a 33-ft. switch are (1) the length being the same as that of stock rail (unless a special length of stock rail is used), one joint of the latter must necessarily come near the point of the switch and the other joint ahead of and near the heel of the switch, often necessitating the clipping of the angle bars; (2) the great length of laterally unsupported rail.

But the location of the joints of the stock rail 40 in. ahead of the point and heel of switch is not seriously objectionable and the clipping of the angle bars is not an expensive operation and does not seriously weaken the joint. Switches 33 ft. and even 45 ft. long have been successfully used to such an extent that there seems to be little ground for apprehension on account of the length of laterally unsupported rail. Lengths of 27 and 30 ft. have been suggested; the angles would be respectively 22 and 10% greater than for 33 ft.

The longest switch points are to be used in those turnouts where the highest speed is desired. These switch points

†From the report of the Committee on Track.

Record of Tunnel Ventilation

Under Plans of Chas. S. Churchill and C. C. Wentworth

Tunnel	Date Installation of	Rate of grade	Location of fans	Length, ft.	Section, sq.ft.	Contents, cu.ft.	Cu.ft. air delivered per min through tunnel	Remarks
N. & W. Ry. Elkhorn, Coaldale, W. Va.	6-01	+1.4% E	Lower end	3000	ST 235	705,000	400,000	Train ton rating inc. in 1901, 100 tons
C. & O. Ry. Big Bend, E. Hinton, W. Va.	12-02	⅜ Lgth +0.4% E	Upper end	6500	ST 250	1,625,000	300,000	Train ton rating inc. 228 tons
P. R. R. Gallitzin, W. Altoona, Pa.	4-05	+0.5% W	Lower end	3600	ST 324	1,166,400	502,000	.....
P. R. R. Washington, D. C., station	12-07	+0.13% S	Upper end	Tubes 4050 sta. 76026	1 tube 260 tracks	3,371,800	640,000	2 tubes, 520 sq. ft. Station end variable
P. R. R. North and East Rivers, N. Y.	9-10	Special installation 14 fans for emergency uses, vent. of tubes that are 4135 ft. to 7357 ft. long		.....	225	.....	40,000 to 111,000	.....
B. & O. R. R. Kingwood, Tunnelton, W. Va.	12-10	+1.0% E	Lower end	4138	ST 352	1,458,000	600,000	Train ton rating inc. 150 tons
C. & O. Ry. Lewis, Alleghany, Va.	6-11	+1.14% W	Lower end	4026	ST 318	1,280,200	508,800	.....
N. Y. C. lines Weehawken, N. J.	8-11	+0.25% E	Lower end	4365	DT 469	2,047,200	512,000	144 trains per day
P. R. R. B. & P. tunnel, Baltimore, Md.	9-11	+1.32% S	Upper end	4963	DT 432	2,150,000	300,000	193 trains per day

will necessarily get severe usage, therefore they should be made from the very best rail. If made from the second or third rail from the top of the ingot, they eliminate as far as possible any chance of defect in the rail. These rails are, as a rule, 33 ft. in length. The lengths of switches recommended can be made from 33-ft. rails without any waste.

These and other considerations led the committee to recommend the following length of switch points for the four general classes of turnouts named above: (a) 33 ft.; (b) 22 ft.; (c) 16½ ft.; (d) 11 ft.

SWITCH AND FROG ANGLE—A purely theoretical investigation of the rate of turning of a locomotive at the switch point and of the angle between the stock rail and a line passing through truck centers of a car leaving the switch, indicates that an approximate balance between the deflection through the switch point and the deflection through the lead is attained when the switch angle equals one-fourth the frog angle. This proportion has been found to work out well in practice. It seems to be certain that when the switch angle exceeds one-fourth the frog angle, the switch point presents the worst feature in the alignment of the turnout and there is an economic loss both in the space occupied by the turnout and in the cost of the turnout.

With a 6¼-in. heel distance and ¼-in. thickness of point, the above relation between switch angle and frog angle would make the length of the switch in feet equal to twice the frog number.

FROG NUMBERS—In 1908 the frogs most used appear, from a table compiled by the ENGINEERING NEWS, to have been Nos. 10, 7, 8, 9, 6, 15, 12, 20, 11, 14 and 16 in the order named; No. 10 frogs being used by 55% of the roads tabulated and No. 16 by only 5%. But the roads using No. 11 included the Chicago, Burlington & Quincy, Great Northern, Michigan Central and Northern Pacific; and those using No. 16 included the Baltimore & Ohio, Erie and Lake Shore & Michigan Southern.

No. 7 frogs are rapidly disappearing, being supplemented by No. 8's; the relative number of No. 10's is also diminishing, with a corresponding increase in the proportion of frogs of higher numbers.

It seems desirable for class A turnouts to use the highest number of frog which is economically consistent with the longest switch point. For class B, the great preponderance of present practice is in favor of No. 10 frogs, but the choice of this frog would leave an unfilled gap between this and the highest number frog; besides, a No. 10 turnout with a 16½-ft. switch is little better in its worst feature than a No. 8 turnout with the same switch, while a 22-ft. switch would unduly increase the degree of lead curve. For class C the trend of present practice, if not the preponderance of practice at this date, is in favor of No. 8 frogs. For class D, no number of frog can be specified, as this class includes a multitude of special cases.

RECOMMENDATIONS—For frogs over No. 6 up to and including No. 10, 16½-ft. switch points are recommended; 22-ft. points for frogs over No. 10 up to and including No. 14; 33-ft. points for frogs over No. 14, and 11-ft. points for No. 6 and under where they are required.

Frogs of Nos. 8, 11 and 16 are recommended as meeting all general requirements for yards, main-track switches and junctions. New work should be laid out, so far as practicable, for these three frogs, so as to effect the gradual elimination of frogs of other numbers, lessen the cost of manufacture and decrease the amount of stock carried.

TESTS OF SHEET PILING*

The procedure suggested for these experiments was that a strong concrete open-top box be made, across the middle of which a vertical plate diaphragm of tempered spring steel could be set; this diaphragm being held in place against horizontal motion at its top and bottom. On both sides of this diaphragm the box would be simultaneously filled with the material to be tested, as sand; thus representing (when the box is full) sheet piling driven in sand.

The sand was then to be removed from one side of the diaphragm, as would occur when a trench is excavated protected by sheet piling. After the diaphragm had assumed the curve due to the pressure of the sand its curved shape was to be accurately determined and a closely fitting template made to record its curvature.

In order to determine the amount and distribution of the sand pressure, the diaphragm would then be removed from the box and placed horizontally, supported at its ends at the same points it was supported by when vertical in the box. A number of metal strips should be provided, each long enough to reach across the diaphragm, but of varying thickness to make up any required weight, and of equal width.

These would be piled at equal intervals on the diaphragm until it reaches the exact curve of flexure which was given it by the sand and recorded by the template; bearing in mind that the tops of the successive piles of metal strips must be on a curve of some uniformity (which may be called the curve of load) without such irregular outline as that of a battlement, and carried over the supports on the line indicated by the curve approaching them. The total pressure, and the center of pressure, would thus be determined, it is thought, with considerable accuracy.

As a check, the flexure curve of the diaphragm already found could be plotted to a convenient scale, and successive differentials taken thereof up to and including the fourth. As the equation of this flexure curve is unknown, the differentiation would be done graphically, remembering that the first differentiation gives the curve of tangents to the flexure curve; the second the curve of moments; the third the curve of shear, and the fourth the curve of load, which should agree with the curve of load determined by the first method—that of weights superimposed on the horizontal plate.

Other materials than sand need testing, such as a heavy semi-fluid mud, and ballast. In each case the angle of repose would be noted of the unretained material, and its weight per cubic foot.

In order to obtain definite conclusions the concrete box and steel diaphragm should be of rather large size; and to prevent the friction of the retained material on the sides of the box from affecting the result materially, narrower steel plates could be placed on each side of the main diaphragm, observations being taken on the main plate only.

The investigation could be extended to determine the pressure on abutments, which are generally filled against gradually on one side only. It seems probable that under such mode of filling, the total pressure would be greater, and its center lower, than in the case of sheet piling.

WATERPROOFING MASONRY†

Impervious concrete can be made without special waterproofing, by (1) using a suitable gradation of aggregates and the proper amount of cement, (2) reinforcing the concrete to counteract temperature and shrinkage stresses, and (3) in depositing to use the proper care and amount of work to secure a dense concrete.

In using waterproofing material such as felt, in connection with coal-tar pitch or asphaltum, fair results are obtained, when the weather conditions are favorable, and when the work can be done without interference or obstructions and by working continuously until completed. When the work is done at an unfavorable season, or when work is done in distinct separate periods and sections, under difficulties such as track operations, undue haste in completing the work necessitated by special circumstances, the results have generally been unsatisfactory.

The 24-Hr. Time System in which the hours of the day and night are numbered from 0 to 24, beginning at midnight, is to be adopted on the French government railways, beginning with next summer's schedule.

*From the report of the Committee on Wooden Bridges and Trestles. A discussion of "The Strength of Sheet Piling," by the same committee, was published in our issue of June 15, 1911.—Ed.

†From the report of the Committee on Masonry.

Laying a Submerged Flexible Joint Water Main in a Swift Mountain Stream*

By Frank Reed†

The extension of a 30-in. water main for hydraulic-mining operations in New Zealand included the building of a 2-mile inverted siphon and the crossing of a swift mountain stream.

This mountain river, the Taramakau, flows from the Southern Alps, which lofty range constitutes the backbone of the South Island of New Zealand. From the base of the ranges to the Tasman Sea the distance by river is about 15 miles, over which the inclination of the river bed averages 5 ft. per mile, and the velocity of the current varies between 4 and 6 miles per hour, dependent upon the volume of water flowing.

At the line of crossing, which was chosen on account of the even shingle and sand bottom, freedom from snags, and from evidence of scouring, the width of the stream varies from 650 ft., at time of low water, to 2900 ft. in time of high flood, the maximum depths being 7 ft. and 18 ft., respectively, under the two different conditions.

Methods of Lowering Pipe.—In the United States several methods have been employed, viz.:

(1) Lowering by ropes and derricks from the downstream side of barges or floats, sections of flexible-joint pipe, which, when of large size, are supported during lowering by a cradle, truss, or other suitable apparatus.

(2) Floating the main onto the line of crossing, and sinking in one section, the whole length being previously joined together on the upstream bank. This method is applicable to light malleable-iron or steel pipe, crossing streams having an even bottom and little current.

(3) Lowering by Phillips' patent caisson into a dredged trench disconnected sections of the pipe, to be joined and calked by divers. This method has been employed in harbors for sewage outfalls beyond low water, but it is not at all advisable that joints which are to be subjected to high pressure should be made under water by divers; to make such joints watertight, when working ashore under favorable conditions, requires careful work.*

In the case of the Taramakau River crossing, the abnormal conditions to be encountered, on account of the velocity of the current and the frequency of sudden and high floods, precluded the application of any of the above methods, and it was decided by the author to use specially constructed pontoons (Fig. 1) separated by a well-hole, in the manner of a bucket-and-ladder dredge.

The pontoons were connected overhead by strong trussed gantries, from which a steel joist was suspended longitudinally above the well-hole, for carrying three differential traveling pulley blocks, each of 7 tons' capacity, by which the pipe could be carried and, when joined, could be lowered down the well-hole to the river bed. By this method the operation of lowering was better controlled in the swift stream.

Pipes and Flexible Joints.—The type and thickness of the main were determined by under-water conditions; risks of failure were minimized by a due regard to outside influences. All ironwork was designed for a working pressure of 152 lb. per sq.in., and was subjected to a hydrostatic test of double that pressure before leaving the foundry and again at the site of operations. Cast iron was the metal chosen, its weight being calculated to resist movement by current, and its thickness to withstand wear by traveling shingle. All pipes were of 1¼-in. metal, 30-in. diameter, and 12 ft. in length.

The flexible joints (Fig. 3) were of 1½-in. metal, and were constructed on the ball-and-socket principle, with a water-tight joint of lead filling recessed into the socket. To secure perfect fitting, a portion of the inside of the socket was accurately machined by means of a special ball-rest to form the middle zone of a sphere, and the surface of the ball was turned to form a segment of a sphere accurately fitting the socket. Flanged collars, which could not readily be pulled apart, supported the lead filling and held the two sections of the joint together.

A maximum deflection of 13° was provided for, which permitted a section of 36 ft. of pipe (between flexible joints) to be lowered in 7 ft. of water, while the free end remained supported on the pontoon. Further deflection, which would be liable to split the ball, was prevented by stops.

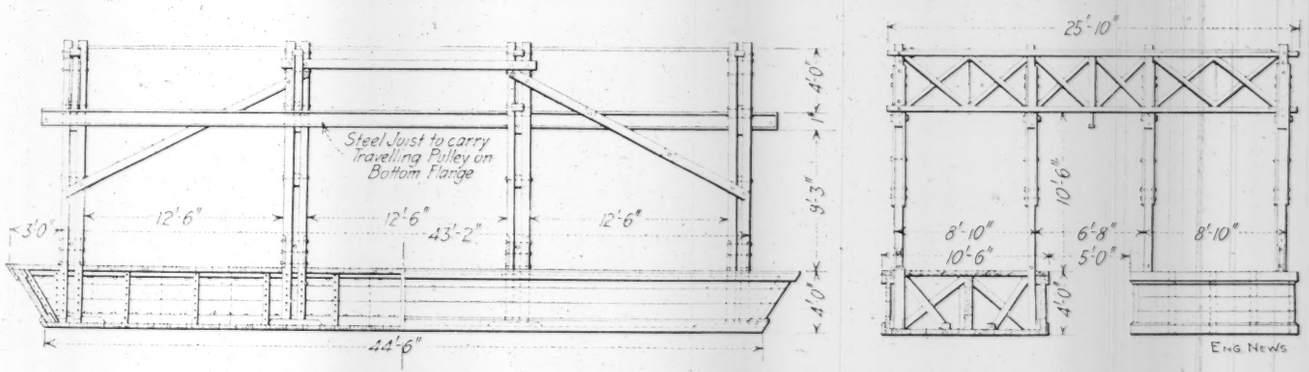


Fig. 1. Pontoons Used for Laying a 30-in. Cast-iron Water Main under a New Zealand Mountain Stream

All flange faces were recessed to receive a malleable-iron packing ring, 30¼ in. by ¾ in. by ⅛ in., bound with hemp and well coated with a mixture of red and white lead, which has been found to form a most permanent and satisfactory joint in New Zealand hydraulic mining mains. All under-water flanged pipe should preferably have bronze bolts, but in this case the author inserted gun-metal and steel bolts alternately, as it was found that the heads of some of the 1⅛-in. gun-metal bolts were pulled off when tightening up the joints.

Pipe Laying.—The pontoons were moved into position by steel cables on the line of crossing, upon each side of which there had been driven, at a distance apart of 20 ft., mooring piles spaced 40 ft. on the upstream and 80 ft. on the downstream side. Upon the somewhat steep inshore slope, permanent skids were placed to carry the shore main to the river bottom, where the first flexible joint would be fixed.

The pontoons were then brought to these skids, upon which, above water level, rested a section of pipe with a

*Paper read before the Institution of Mining and Metallurgy, London, England, Jan. 18, 1912.

†M. Inst. M. M., Mines Dept., Wellington, New Zealand.

*A method very similar to the one described in this article was used in laying a 36-in. water main under Harlem River, New York City, in 1899. A description of the work will be found in Engineering News of Mar. 22, 1900. The scow used was equipped only with a derrick and launching ways, into which the pipe was lifted by steel cables. The weight of the pipe over the end forced the scow ahead fast enough for all purposes. The same method was also used in 1904 for a 24-in. water main at North Tonawanda, N. Y., described in Engineering News of Aug. 4, 1904. In this case the launching ways extended to bottom and the pipe was allowed to slide down by moving scow ahead.

flexible joint attached at the free end. Upon the pontoons three pipes were also connected together and carried upon a cradle 40 ft. in length, which was suspended over the well-hole by chains from the traveling blocks previously alluded to.

After all joints had been carefully

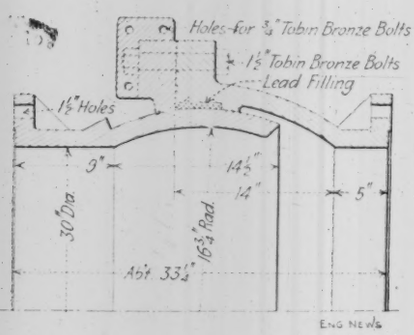


FIG. 2. SECTION OF FLEXIBLE JOINT ALLOWING 13° DEFLECTION

examined, the section of pipe on the pontoons was connected at the flexible joint with that section resting upon the shore skids; the pontoons were then drawn forward directly on the line of crossing, while the cradle and contents were being dipped obliquely down the well-hole at the shore end until the flexible joint was deposited in its permanent position on the river bottom immediately at the end of the fixed shore skids, the free end of the pontoon section of pipe being now made fast on the inshore end of the vessel at deck level.

During this movement the shore pipe was launched down the skids into its permanent position. The cradle was then withdrawn from under the suspended pipe and raised by traveling blocks to its first position at deck level, there to receive another section of pipe. A flexible joint was then attached to the free but supported end of the main; another section was put together on the cradle, attached to the flexible joint and submerged as before, and the operation repeated until the 650 ft. of river bed was crossed, which occupied 104 hours' actual working time.

On the occasion of a flood descending during the process of laying the pipe, a blank flange was bolted to the supported free end of the main to prevent the entrance of water; it was then buoyed and lowered to the bottom, to be raised again when operations were resumed. Only one such emergency arose, however, the river rising 9 ft. in one night, but no harm was experienced on that occasion.

Finally the main was permanently anchored by heavy chains to each upstream pile (spaced 40 ft. apart) to resist downstream settlement, but this precaution was probably superfluous, subsequent examination showing all chains to have remained slack. All piles were then cut off near ground level, to avoid interference with floating timber.

During the whole process, the pipe-laying pontoons were never moved from the center line, all supplies being transported thereto by a smaller pontoon, operated from a steel cable suspended across the river on the upstream side, to which cable the transport pontoon was connected by ropes and single block, the current providing the motive power.

EFFECT ON RIVER BED—It was found, almost immediately after the pipe was submerged, that the current was deflected underneath by the lower side of the main, scouring a shallow trench into which the pipe settled, and this action continued until the main was buried for half its depth, when scouring ceased and the deflection of water turned upward, over the rounded top of the main. Absolutely no scour occurred on the downstream side, the pipe having settled in its self-made trench. Subsequently, the upper side silted up, thus protecting the main from the power of the current, from wear by traveling shingle, and from descending snags.

No preliminary dredging was undertaken in connection with this work, owing to the impracticability of bringing a dredge into operation, and it must be admitted that no ill results followed the omission of this somewhat important precautionary measure. Water was not admitted to the main until it had settled into its scoured trench and the shore ends were left unjoined until settlement had ceased and the line was fully contracted.

CONCLUSION—As regards cost, there can be no comparison between a pipe

FIG. 3. METHOD OF LAYING A 30-IN. SUBMERGED WATER MAIN IN NEW ZEALAND

bridge and a submerged flexible-jointed main, for the total cost of the Taramakau crossing did not reach $25 per lin.ft., which included all expenditures, no deductions being made for practically new pontoons and plant at the completion of operations. A pipe bridge would have cost much more than this.

The Timber Supply and the Railways*

CONSUMPTION—The Bureau of Corporations estimates that there is a total of about 2800 billion board ft. of standing timber in the country. Of this about 2200 billion ft. are privately owned, about 539 billion ft. are in the national forests, and about 90 billion ft. are on the unreserved public lands, national parks, state lands, and Indian reservations.

The earliest attack was upon the white pine of the Northeast, the original stand of which is almost entirely cut out. At the present time the two great sources of timber supply, so far as privately owned timber is concerned, are the Pacific Northwest, with 1013 billion ft. and the Southern pine region, with 634 billion ft. Moreover, 82% of the standing timber owned by the U. S. government is in the Pacific Northwest, and nearly all of the remainder is in the other states of the Rocky Mountain region.

The yearly growth of wood in our forests does not average more than 12 cu.ft. per acre. This gives a total yearly growth of less than 7 billion cu.ft. That our forests grow very slowly, although the individual trees of many kinds grow fast, is our fault. There are about 200 million acres of mature forest mainly in the northern Rockies and on the Pacific Coast in which the yearly growth is balanced by decay.

There are 250 million acres, mostly in the Southern mountains and Southern pine belt, partly cut or burned over, but restocking naturally with young growth; and 100 million acres chiefly in the Lake States and Southern pine belt which have been cut or burned over upon which young growth is wholly lacking or too scanty to make merchantable timber.

There is taken from the forest annually, not including loss from fire, 23 billion cu.ft. of wood, or over three times its yearly growth. This large consumption amounts to 230 cu.ft. per capita, while Germany uses 37 and France 25 cu.ft. Each year there are used 90,000,000 cords of fire wood, 40,000,000,000 board ft. of lumber, more than 1,000,000,000 posts, poles and fence rails, 118,000,000 hewn ties, 1,500,000,000 staves, over 133,000,000 sets of heading, nearly 500,000,000 barrel hoops, 3,000,000 cords of native pulp wood, 165,000,000 cu.ft. of round mine timbers, and 1,250,000 cords of wood for distillation.

The condition of the world supply of timber makes us already dependent upon what we produce. There is exported out of the country 1½ times as much timber as is brought in, and except for finishing woods (relatively insignificant in quan-

*Extracts from the report of the Committee on Conservation of Natural Resources, presented at the annual meeting of the American Railway Engineering Association, held at Chicago, Mar. 19-21, 1912.

tity) we must rely upon our own resources for the future supply.

The Forest Service estimates the yearly drain on the saw timber of the country at about 50 billion board ft. Without allowing either for new growth or for any increase in the rate of consumption the total for all the timber in the United States would represent about 55 years' supply, and that for privately owned timber alone only 44 years' supply.

These conditions affect the railways of the country not only as they are concerned in the production of timber for their own use, but from the broader viewpoint of developing the territory traversed by their lines. The destruction of the timber is followed by a rapid decline of the industries utilizing the products of the forest, with a corresponding loss of revenue for the roads serving the region.

CONSERVATION—Turning our attention to the conservation of the forest it will be seen, (1) that by the introduction of proper forestry methods the annual productivity of the forest can be considerably increased, and (2) that the yearly loss from avoidable causes is much greater than it should be.

There are 225 million acres of producing forest in the country. On this area the stand is so open that all the trees could be grown on 145 million acres, which would be producing at the rate of 70 cu.ft. per acre annually. By growing only the best species this growth can be increased to 80 cu.ft., an increase of 1450 million cu.ft.

There is an unutilized area of 80 million acres within our present producing forest. There are 135 million acres of absolute forest land within our virgin or mature forests now unproductive. There are 90 million acres of waste lands which can be made productive by planting, or by fire protection all of these areas can be made to produce 80 cu.ft. per acre, or a total of 24,400 million cu.ft. The total increase possible in the productiveness of our forests is, therefore, 25,850 million cu.ft.

Only 25% of the yield of our present producing forest is saw timber. It can be made from 50 to 75% saw timber through the concentration of growth on the best trees by thinning and the holding of the crop until it reaches good size. This would mean an increase, if all our forest land were productive, from 27,000 million board ft. to between 54,000 million and 81,000 million board ft. per annum.

The enormous loss from fire in our forests every year is a matter of common knowledge. The value of standing timber destroyed each season from this cause has varied from $25,000,000 to more than $100,000,000, the direct annual loss in recent years averaging considerable over $50,000,000. The destruction of young growth, though never included in estimates of fire damage, is a principal item of loss. The natural restocking of burned-over lands takes place very slowly or not at all. All experiences go to prove that damage by forest fires is practically preventable. This stage of development has already been reached in Europe. For example, of 7 million acres in Prussia, an average of only 1400 acres, or one-fiftieth of 1% was burned over each year during the period from 1868 to 1895.

The railways, by working with the state forestry officials, can accomplish a great deal of good in the way of prevention of fires started by sparks from locomotives. A concerted action on the part of the railways and state officials is desirable, as the forest adjacent to the railway right-of-way is often left in such a condition after logging operations that it is a difficult matter to prevent fire starting, even when the greatest precaution is observed. Several roads are now working with the state foresters to accomplish this result; notably the Chicago & Northwestern Ry. in Wisconsin.

While the chief loss in timber is due to fire, other causes contribute largely to the prodigious waste which has accompanied our use of the forest. In logging, 25% of the standing timber is left or otherwise lost. The boxing of long-leaf pine for turpentine has destroyed 20% of the forests worked. The loss in the mill is from 33 to 66% of the timber sawed. The loss in the mill product through seasoning and fitting for use is from 14 to 25%. Great damage is done by insects to forests and forest products. An average of only 320 ft. of lumber is used for each 1000 ft. which stood in the forest.

Of all the wood in every form now in use in the United States, decay, fire, insects and saltwater borers destroy not less than the equivalent of 8000 million board ft. each year. Of these, decay is far the most destructive.

PRESERVATION—In 1880, the United States census undertook to ascertain what remained of our timber resources; it was found that they had been very rapidly depleted. Realizing the importance of the question the American Society of Civil Engineers appointed a committee to report upon the best methods of preserving wood, in order to lengthen its life. This committee was appointed in 1880 and presented its report in 1885. This was followed by the movement which has culminated in the present large wood-preservation industry of the country.

In 1910, about 97,500,000 cu.ft. of timber was treated. Most of this consisted of cross-ties. About 65% were treated with creosote, and the remainder with zinc chloride and zinc creosote.

REFORESTATION—In the United States the science of forestry is still in the formation stage. Knowledge of the characteristics and requirements of the many species of trees composing the forests is limited; the total amount and distribution of forest wealth is not accurately known; and methods of administration are not yet settled, but are subject to frequent change. In Europe, on the contrary, forestry as practiced today is the result of centuries of gradual evolution, and is consequently thoroughly systematized and its methods firmly established. Foreign silvicultural methods are not usually applicable without change, but the general systems have been adapted with success to conditions in this country, and should be still more widely used.

A striking point concerning forestry abroad is the important part taken by the state in the management of communal and private as well as of the state forests, and the considerably greater returns obtained under state management. All communal forests are subject to some form of state supervision, and many of them are managed precisely as if they were state property.

Private forests necessary for the protection of water sheds or the welfare of the general public are also subject to state control; they cannot be cleared, cutting must be done as prescribed by the state, and all cuttings must be reforested. Other private forests not necessary for protective purposes can usually be managed as the owner desires, but coöperation with the state in the management of such forests is common.

With a few exceptions, comparatively little attention has been paid by the railways to forestry. Tree plantations have been started in a number of cases, some of which have been on a large scale, but for the most part experimentally. Forest planting in some cases may be desirable when a railway has waste land for which it has no particular use. It is a good object lesson to the farmers, and if the plantations are successful they will net a fair return on the investment and furnish a limited supply of ties and timber for the future.

It should be observed, however, that it would not be practicable for the individual roads to plant enough trees to supply their timber requirements, and further the critical period of scarcity and high prices would come before any of the trees so planted would reach maturity.

If the railways wish to provide against future scarcity and excessive prices with any degree of certainty it will be necessary for them to actively engage in forestry operations having for their purpose the management of mature timber lands and the cultivation and reforestation of the cut-over lands within the forest area. This is an individual problem with every road, but generally speaking it is the only sound policy which will provide for the future requirements 15 or 20 years hence.

Some of the railways have now undertaken to preserve the timber lands which they acquired through land grants and

otherwise. The Southern Pacific in northern California and southern Oregon still has large areas of good timber from which it can cut mature trees. The Northern Pacific has been coöperating with the government for some years with a view to finding how best to handle its western holdings and provide a source of tie supply at the eastern end of its lines. In the East, the Delaware & Hudson has put about 100,000 acres in the Adirondacks under management.

Progress of the Diesel Oil Engine*

By Dr. Rudolph Diesel†

Over 300 vessels are now afloat or under construction propelled by Diesel oil engines. This number includes 115 submarine torpedo boats, 30 other naval vessels, and a number of freight and passenger merchant vessels of 1200 to 3000 h.p.

The United States lags behind all other industrial nations in the adoption of this engine for marine, naval and stationary use.

France has over 60 submarine boats equipped with this engine. The United States has two just completed.

The Diesel engine can use not only petroleum oils but tar oils, and oils produced by the distillation of lignite and shale. It has the highest fuel efficiency of any commercial heat engine.

*A paper read before the Institution of Mechanical Engineers of Great Britain, Mar. 15, 1912.

†Munich, Germany.

Since its first appearance, about 14 years ago, the Diesel engine has been built by the thousand in the best factories of all industrial countries, and has been set up in the most remote corners of the world.

It has been proved to be a most reliable engine when properly built, the working of which is quite as safe as that of any other system of prime mover; and in general it is even more simple, since it does not require any auxiliary apparatus, and since the fuel in its natural and original form, without having previously undergone any transforming process, is directly converted into work in the cylinder of the engine.

As early as 1897, when, after spending four years' time in difficult experiments, the author had put the first engine into working order in the factory of the Augsburg Works, numerous engineering representatives and experts who came from various countries to examine this engine expressed the opinion that it gave better heat utilization than any known kind of heat engine. From experience gained subsequently by working many engines, by gradual improvements in the construction and manufacture, and by increasing the sizes, the results have been still further improved, and today the thermal or indicated efficiency reaches 48% in this engine, and the effective or brake efficiency reaches, in some cases, 35% of the heat value of the fuel.

Science and technical knowledge are all the time making continuous progress, and the time will come when even these figures will be exceeded; but, with out present scientific knowledge, any considerably higher efficiency in the process of transforming heat into mechanical work is not obtainable. Further progress seems only possible with some other method for transforming heat into work; this would mean an entirely new principle, which, however, one cannot speculate upon in the present state of science.

The Diesel engine is therefore the engine which converts the heat of the natural fuel into work in the cylinder itself, without any previous transforming process, and which utilizes it as far as the present standard of science permits; it is therefore the simplest and, at the same time, the most economical prime mover.

These two facts explain its success; it lies in the new principle of the internal working process and not in constructional improvements or alterations of older types of engines. There is no doubt that the careful working out of all the constructional details also plays a great part in the practical success of the Diesel engine, as in any other; but they are not the essential points, and above all they do not constitute the great importance of this engine to the world's industry.

A further reason for this importance is that the Diesel engine has broken the monopoly of coal. At the Turin Exhibition, last year, a steam turbine and a large Diesel engine, both made by Franco Tosi, of Milan, and set up on the same stand, were worked together with the same liquid fuel. The boilers furnishing steam to the turbine burned crude oil. The difference between the two plants was therefore this: for the working of the steam engine the whole boiler plant with its chimney, fuel-supply apparatus, purification plant for feed water with feed pumps, extensive steam pipes, condensation plant with water pumps and an enormous water consumption, had to be provided, with the final result of consuming 2½ or more times the fuel per horsepower required by the Diesel engine standing beside it. The latter, being an entirely independent engine without any auxiliary plant, took up its crude fuel automatically and consumed it direct in its cylinders without any residue or smoke. A better proof can hardly be imagined, even for the non-technical man, that except in special cases the steam engine cannot compete economically with the oil engine. It is hardly possible for a country which produces no coal, like Italy, to develop a great industry based on the steam engine, and this is one reason for the exhibition at Turin of about thirty Diesel engines of various types and sizes, and made in different countries.

Thus the Diesel engine has doubled the resources of mankind as regards power-

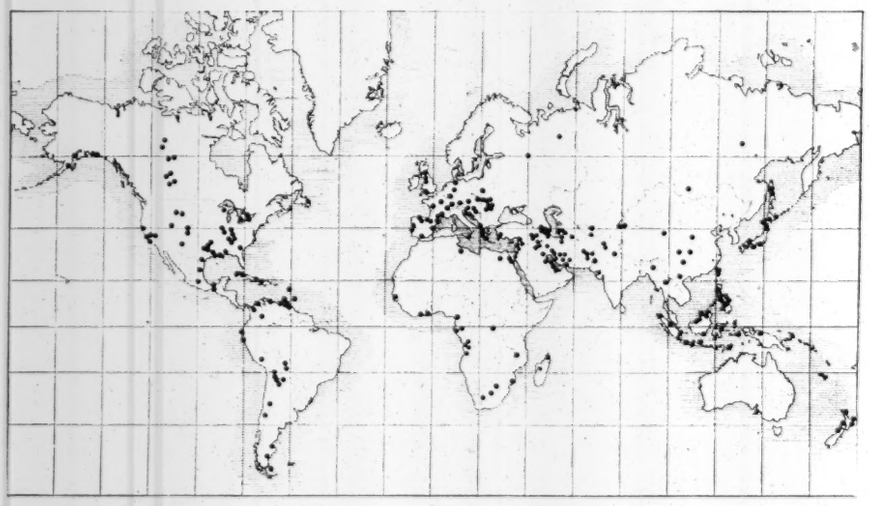


FIG. 1. MAP SHOWING PETROLEUM FIELDS OF THE WORLD IN THE YEAR 1908

production, and has made new and hitherto unutilized products of nature available for motive power. The Diesel engine has thereby exercised a far-reaching influence on the liquid-fuel industry. It has been proved by recent geological researches not only that there is probably on the globe as much, or perhaps even more, liquid fuel than coal, but also that it is more conveniently distributed as regards its geographical position (see Fig. 1). The world's production of crude oil is now increasing 3½ times faster than the production of coal. Only 40% of the present production of mineral oil would be sufficient to supply the whole of the naval and mercantile fleets of the world with power, if they were worked by Diesel engines.

But with all this, the influence of the Diesel engine in the world's industry is not exhausted. As early as the year 1899 the author utilized in his engine the by-products of coal distillation and coke plants, such as tar and creosote oils, with oils. With each cask fresh variations appeared even in cases where the works guaranteed the use of the same coal, and the carrying out of the same distilling process, so that it was impossible to make scientific observations for drawing any definite conclusions, or making logical experimental arrangements. The characteristics of crude tar oils were not then exactly known even to the producers; for instance, nobody imagined that differences in the distilling temperature and variations in the nature and position of the retorts gave entirely different tar products even when the same coal was used. It is only in recent years that the chemical industries interested in the matter have, by improved methods of fractioning and refining, combined with more careful selection of the material, succeeded in supplying fuel of a constant and regular quality, without the drawbacks of the crude tar oils used previously. These products—the tar and tar oils—are thus today definitely brought are first extracted, and undergo further processes in the chemical industry, whilst the tar oils and combustible byproducts, and a great part of the tar itself, are burned in the Diesel engine under extraordinarily favorable conditions.

The list of fuels applicable to the Diesel engine is not, however, exhausted with these liquid fuels mentioned previously. It is known that brown coal or lignite, the production of which is about 10% of the pit-coal production, also yields tars by distillation, and these tars when distilled produce the so called paraffin oils as byproducts. To these must be added other products, such as shale and similar oils. Some countries—France and Scotland, for instance—possess them in considerable quantities, and they are used in a good many Diesel engine plants. It is not generally known that it is also possible to burn vegetable oils and animal oils in the Diesel engine without any difficulty.

At the Paris Exhibition in 1900 there

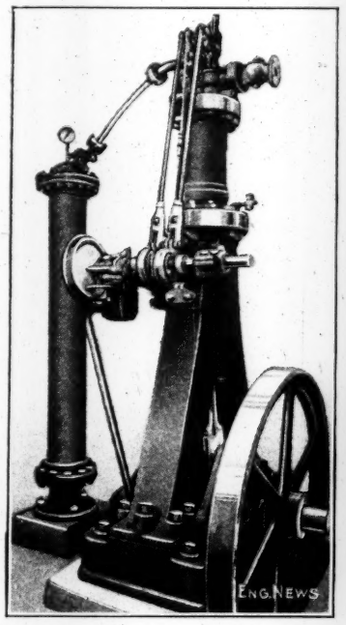


FIG. 2. FIRST EXPERIMENTAL DIESEL ENGINE, 1893

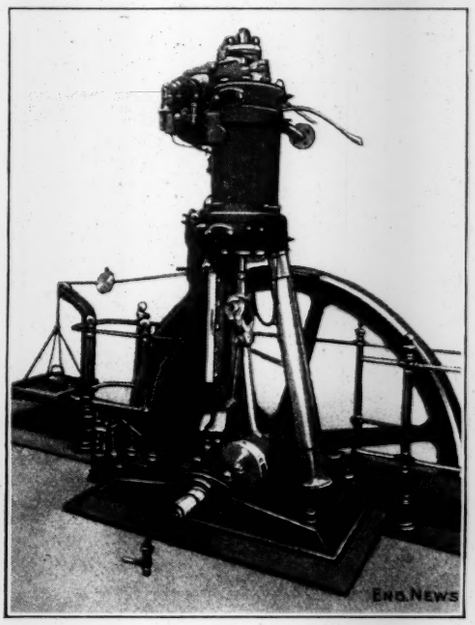


FIG. 3. FIRST COMPLETE DIESEL ENGINE, 18-HP., 1897. SHOWING BRAKE AND OTHER TESTING APPARATUS

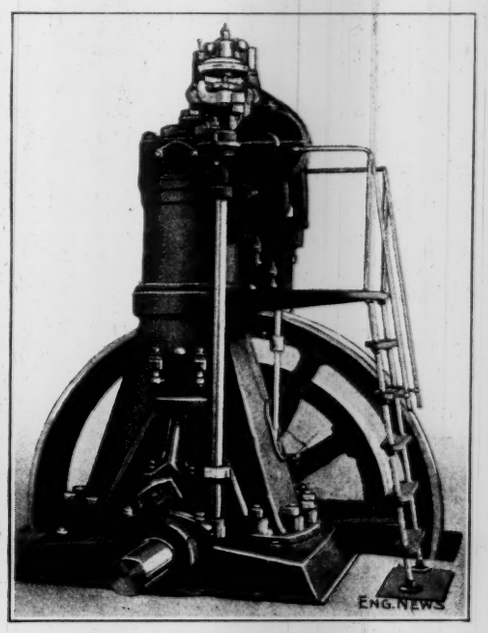


FIG. 4. TRUNK PISTON TYPE, 70 TO 90-HP., 1901. CYLINDER 15.75-IN. DIAM.; 26.62-IN. STROKE; 150 R.P.M.

the same satisfactory results as with natural liquid fuels, but at that time the quality of these oils was generally too inferior for their use in the Diesel engine, and it was, moreover, subject to continual variations.

The difficulties were then chiefly the following:

(1) Muddy deposits of solid hydrocarbons, especially naphthalenes, which made the working of the fuel pumps difficult, filled up the pipes and nozzles, and formed a hard crust at the nozzle mouths. These solid hydrocarbons also made higher ignition temperatures necessary.

(2) Continuous change in quality and composition of the crude, uncleaned tar into the sphere of activity of the Diesel engine.

It is especially noteworthy that every town gas works with a modern installation, and every coke works, can have added to it an electric power-generating plant using its tar for fuel. As tar and tar oils are from 3 to 5 times better utilized in the Diesel engine than coal in the steam engine, a much better and more economical utilization of coal is obtained if, instead of being burned under boilers on grates in a wasteful way, it is first transformed into coke and tar by distillation. Coke is used in metallurgical and other general heating purposes; from a part of the tar the valuable byproducts was shown by the Otto company a small Diesel engine which, at the request of the French government, ran on peanut oil, and worked so smoothly that only very few people were aware of it. The engine was constructed for using mineral oil, and was then worked on vegetable oil without any alterations being made.

Successful experiments have also been made in St. Petersburg with castor oil; and animal oils, such as train oil, have been used with excellent results. The fact that oils from vegetable sources can be used may seem insignificant today, but such oils may perhaps become in course of time of the same importance as some natural mineral oils and the tar products

are now. Twelve years ago the latter were not more developed than the fat oils are today, and yet how important they have since become.

One cannot at present predict what part these oils will play in the colonies in the future. In any case, they make it certain that motor power can still be produced from the heat of the sun, which is always available for agricultural purposes, even when all our natural stores of solid and liquid fuels are exhausted.

Historical Summary

The author thinks that a summary of the whole development of the Diesel engine, and of the general points connected therewith, with illustrations of a few engines which mark stages in its evolution, may be of interest to the members.

Four-stroke Cycle Engine

Vertical Stationary Engines—The first experimental Diesel engine (Fig. 2), constructed in 1893, had the piston fitted with a piston rod and external crosshead, the cylinder having no water jacket; the camshaft was arranged very low, and the valves were actuated by means of long rods. The starting storage chamber consisted of a wrought-iron pipe with riveted flanges, and there was no air-supply pump, the fuel being injected directly.

A later pattern had a water-jacketed cylinder and the camshaft was placed higher up. But the most important difference from the old pattern was in the air-spraying pump, the necessity for which was only recognized after several years' experimenting, as without it a smokeless combustion could not be effected.

The first reliable Diesel engine (Fig. 3), of 18 hp., was finished in 1897, at Augsburg, after about four years' laborious experimenting. It was a vertical engine having the piston connected to an external cross-head and worked on the four-stroke cycle. The illustration shows the engine with the testing-brake attached, and with the other testing apparatus exactly in the state in which it was used by the numerous commissions of engineers and experts who came from different countries to examine the engine, as mentioned earlier in this paper. This type was for about ten years the exclusive and almost stereotyped pattern for all Diesel engines, which were built in various countries.

In the following year, 1898, a single-cylinder engine of 20 to 25 hp. was built at the Augsburg Works. The engine had still the external crosshead and guides, and the petroleum pump was actuated by the camshaft in exactly the same way as in the experimental engine. The air pump was cast on the base in exactly the same way, and was driven in both cases by rocking beams from the crosshead.

A two-cylinder engine of 60-76 hp. was made in 1899. The only alteration which was made in the year 1901 was the abandonment of the external crosshead and adoption of the trunk piston shown in Fig. 4. Vertical four-stroke cycle engines of from 10 to 250 hp. per cylinder were constructed after this pattern, and units up to 1000 hp. were obtained by combining several cylinders. These engines ran at comparatively low speeds, from 160-200 revolutions, according to their size, and were of very heavy construction. Their weight was originally from 617-771 lb. per hp., and later from 529-661 lb. per hp. This type of engine was used exclusively as a stationary plant for various industrial purposes. A two-cylinder M.A.N. engine of this type, of 250 hp. or 125 hp. per cylinder, was built in 1902.

A three-cylinder engine of the same type was made by Sulzer Bros., in 1906. The two latter engines show a slight alteration; the petroleum pump is driven from the vertical instead of from the horizontal camshaft, as was the case in the previous engines. The engines built by Sulzer Bros. and by Carels have also a rotating stuffing-box for the fuel needle. This arrangement was first built in Sweden on the author's instructions, and worked successfully.

The author has purposely referred to this type of engine to show that these engines, which have been built in various factories and in various countries, still remain almost an exact copy of the old experimental engine of 1896. Only in America was the design simplified, or rather cheapened, from the commencement by the director of the American Diesel Engine Co., Col. E. D. Meier. In America the engines were built without crossheads from the beginning, an idea which, as already mentioned, was followed in the year 1901 by the European works after the American engines with trunk pistons had proved successful. The Americans also built from the commencement a closed base frame, and this construction, as will be seen later, has also been recently adopted in the European high-speed engines, but in a more refined and better form. Moreover, the American engines had no valves in the cylinder covers. They were placed instead in a chamber cast at the side of the cylinder, which necessitated the fuel needle being placed horizontally between the suction and the exhaust valves. Finally, the Americans, instead of driving the air-supply pump direct from the engine, always set it up independently and drove it either by a small extra engine, by a transmission shaft, or by an electric motor, in the manner in which air pumps are now set up in many Diesel engine plants on board ship. All these alterations were made with the object of cheapening the manufacture, which is the cardinal feature in American practice.

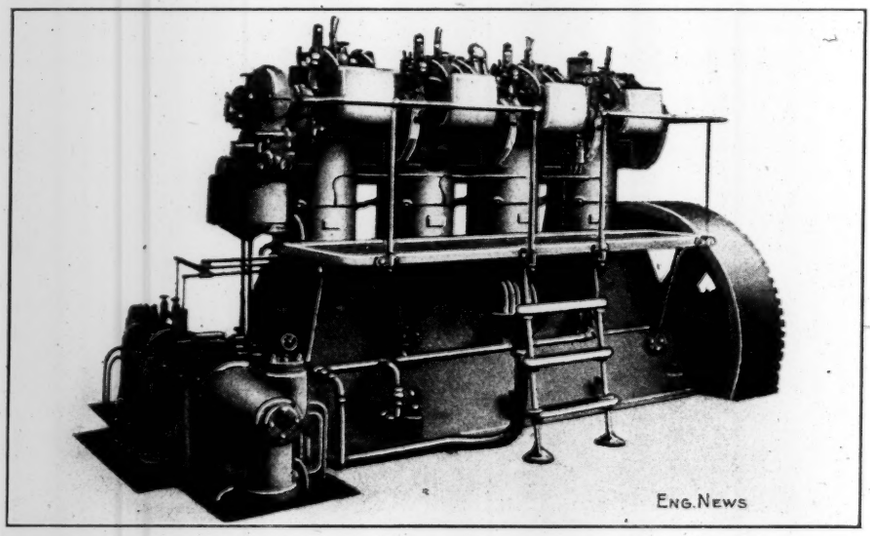


Fig. 5. Four-Stroke Cycle High-Speed Engine, 1909. Showing Box-Frame and Air Pump

A remarkable fact is that the first Diesel engines, built in 1897-1898, are still working, without any change in their fuel consumption; also the first English engine built by the Mirrlees; Watson & Yaryan Co., at Glasgow, according to the author's design of 14 years ago, is still working.

As the central electric stations took up the Diesel engine very early, the necessity for quicker running engines arose. This need, and the improvement in methods of construction and utilization of materials, caused the gradual introduction of the new quicker running four-stroke cycle engines, with speeds of from 300 up to 600 revolutions. These, however, were still exclusively vertical. The main difference in construction as compared with the first type was that the bearings of the crankshaft were connected with the cylinders by means of light steel columns

instead of by heavy cast-iron A-shaped frames, so that the cast-iron pedestal of the machine became a light crank case, relieved from great strain; in addition, the thickness of all the castings was diminished. By this means the weight of the engines was reduced to about one-fourth to one-fifth of the weight of the old types, or to about 110 lb. per hp. Engines of this kind are now built up to about 700 hp. and are especially suitable for driving dynamos, blowers, and centrifugal pumps, and also as auxiliary engines on board large vessels, etc.

In a four-stroke cycle high-speed engine (Fig. 5), made by Messrs. Sulzer Bros., in the year 1909, the only difference, except the box-pattern frame, between it and the arrangement of the old type consisted in the position of the air-supply pump, which was in this case fitted to one end of the engine and driven direct from the crankshaft. In a later four-stroke cycle high-speed engine of 350 hp., made by Messrs. Sulzer Bros., in 1911, the air-supply pump was also driven from the crankshaft, but was fitted between the cylinders on the box-pattern base in a neater way. In this case also no radical alteration has been made.

These latter kinds of engines may be regarded as the final and permanent type of the vertical four-stroke cycle engine for stationary purposes, both for high and low speeds.

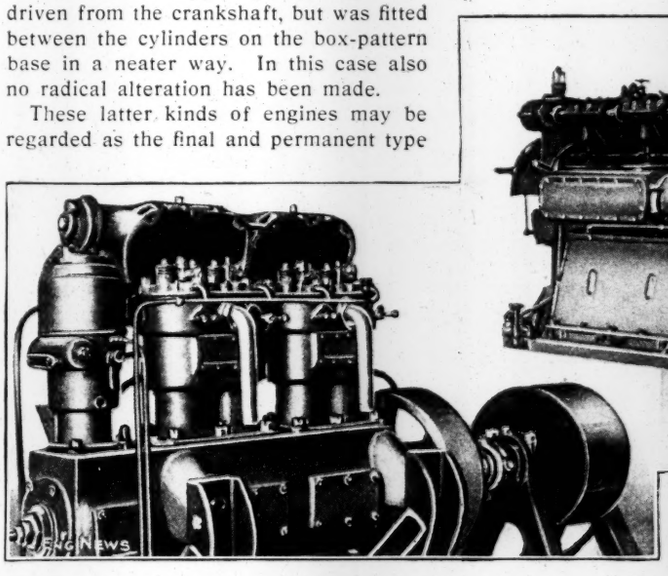


FIG. 6. EXPERIMENTAL REVERSIBLE FOUR-CYLINDER, FOUR-STROKE CYCLE; 30-HP., 600 R.P.M., 1909

Horizontal Stationary Engines — After vertical engines had solely been used for about twelve years, horizontal four-stroke cycle engines were built. The author is uncertain whether this type was a real necessity, or whether it was originally only constructed for purposes of competition to bring out something new; it is, however, not his intention to compare the merits of the two types.

These designs are today very often used for plants of 20 hp. and more, especially by gas-engine manufacturers, who took up the construction of Diesel engines on their own account on the expiration of the patents, and who preferred to keep to the old types of horizontal gas engines. But the M.A.N. built such horizontal Diesel engines for very high horsepowers as double-acting four-stroke cycle engines with two or four cylinders arranged tandem. The largest engine of this kind so far is a double-acting four-stroke cycle tandem twin engine, of 1600-2000 hp. or 400-500 hp. per cylinder, with a speed of 150 revolutions per minute; this engine is working in the corporation gas works at Halle, using water-gas tar as fuel. It was constructed on the lines of the well known Nürnberger large gas engine for blast-furnace gas.

TWO-STROKE CYCLE ENGINES

As very often stated by the author, the Diesel principle is essentially suitable as a two-stroke cycle engine, because the scavenging is not done with a fuel-air mixture, but with pure air, so that not only premature ignitions but also fuel losses are avoided, and the scavenging can be done more effectively, and with almost any quantity of air desired.

The first two-stroke cycle engines on the Diesel principle were built in 1900 and 1901 in Germany and England, after drawings made by Güldner, but without success, because these drawings still followed too closely the two-stroke cycle gas engines, and because the constructional arrangements were unsuited to the Diesel engine.

Successful attempts to construct a two-stroke cycle Diesel engine on entirely new lines have, however, been made recently by Messrs. Sulzer Bros., of Winterthur, so that today this type is on a nearly equal footing with the old four-stroke cycle engine. The author says "on a nearly equal footing," because the four-stroke cycle engine still has a better combustion and a more economical fuel consumption, and is, above all, simpler in its method of working. It thus remains the standard perfect engine, and still predominates for medium-sized stationary plants up to 500 or 600 hp. (no exact limit can be given) wherever the highest perfection and the greatest economy are desired; but engineers are now doubtful whether this supremacy will last much longer. On the other hand, the two-stroke cycle engine with its smaller cylinders has now come into favor for stationary plants of higher horsepower, and, as a marine engine, has become the only standard type.

MARINE ENGINES

The first marine Diesel engine of 20 hp. was constructed in 1902-3, in France, for use on a canal boat, by the French engineers, Adrien Bochet and Frédéric Dyckhoff, in conjunction with the author. Others were also built in various sizes up to several hundreds of horsepower for some French submarines by Sautter, Harlé & Co., Paris.

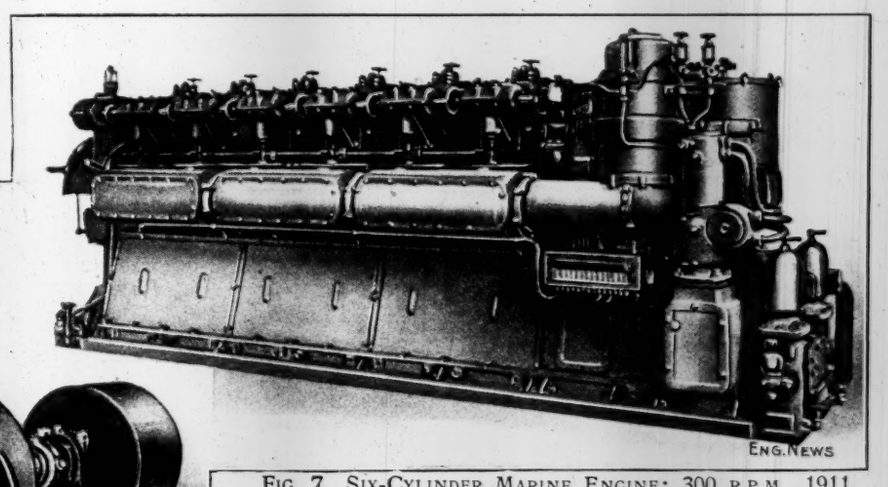


FIG. 7. SIX-CYLINDER MARINE ENGINE; 300 R.P.M., 1911. SCAVENGING VALVES BELOW

Since the date named the evolution of the Diesel marine engine has steadily continued, chiefly on the demand of the French submarines and Russian river boats. The high-speed four-stroke cycle engines, built for electric power stations, were made even lighter than before, and used for French submarines and for Russian river vessels. These engines were not originally reversible; on the contrary they were used to generate electricity by means of which the propellers were driven indirectly for maneuvering. In the most favorable case (Delproposto) the propulsion of the vessel was performed directly by the engine, whilst the maneuvering and slow driving were done by means of electricity.

The first reversing marine two-stroke cycle Diesel engine was built in 1905 by Messrs. Sulzer Bros., at Winterthur; it was exhibited in 1906 at Milan and fitted to a vessel on Lake Geneva in the same year. At that time engineers were not

quite clear as to the importance and value of the two-stroke cycle principle, and many firms went on trying for years to make the four-stroke cycle engine reversible. The first engine of this kind was built by Messrs. Nobel Bros., at St. Petersburg, in the year 1908, and was fitted to a Russian submarine. This problem has recently been solved in a much more simple and neater way, in a six-cylinder 150-hp. reversible four-stroke cycle engine of 350 revolutions, constructed in the year 1911 by the French firm, Messrs. Delaunay-Belleville. This engine is fitted with two air pumps, of which a spare one is for maneuvering.

In many factories reversible four-stroke cycle marine engines are still built, but, on the whole, engineers are, for navigation purposes, inclined to abandon the four-stroke cycle engine entirely and to replace it by the two-stroke cycle engine.

The small four-cylinder engine of 30 hp. and 600 r.p.m., illustrated in Fig. 6, is also a reversible four-stroke cycle engine. It was built for experimental purposes in the year 1909, after designs by the author, as an automobile engine for heavy loads, but it can also easily work as a marine engine. The camshaft is mounted on the cylinder cover, and the illustration shows the engine with the cover lifted.

The illustration above referred to is again of historical value in so far as it illustrates the first attempts to construct the Diesel engine as an automobile engine, and no doubt in future years these experiments, carried out in some different way, will lead to satisfactory results.

Fig. 7 shows a quite new Sulzer six-cylinder marine engine working at 300 revolutions, in which an innovation may be noted. The scavenging valves are not fitted on the top within the cover but below in the scavenging air reservoir.

Quite recently double-acting vertical two-stroke cycle Diesel engines have been built. Fig. 8 shows one of these double-acting two-stroke cycle engines with one cylinder of 1200 hp., made by Messrs. Carels Frères, the results of the tests of which are as yet little known to the public. It is generally known, however, that in the Nürnberg works of the M.A.N. important experiments with double-acting two-stroke cycle engines are being carried out.

In these works prolonged official tests of a three-cylinder double-acting two-cycle engine of 850 hp. were made in August, 1911, and the results proved highly satisfactory. At the present time a double-acting two-cycle three-cylinder engine of 2000 hp. per cylinder is being tested at Nürnberg. The dimensions of these cylinders are as follows: Diameter, 31½ in.; stroke, 41¾ in.; r.p.m., 160.

The air-supply pump for fuel injection is driven by a special Diesel engine, whilst the scavenging pumps are driven direct from the crankshaft.

If, as seems probable, these tests also give satisfactory results, the era of very large Diesel engines has begun, especially low-speed marine engines suitable for driving propellers. This last engine has already yielded considerably more than 2500 hp. per cylinder, so that an engine unit of this kind with six cylinders would give 15,000 hp. or 45,000 hp. for a vessel with three propellers. This kind of marine engine requires six cylinders to ensure a regular turning moment and balancing, so that the number of cylinders cannot be considered abnormally high; on the contrary, it must be accepted as the most suitable and proper number. The opinion which was still prevalent some months ago, that about 1000 hp. per cylinder is the maximum for Diesel engines, has therefore been quickly overthrown by these facts, and it may be safely assumed that the day of the large marine engine is already very near at hand. At Messrs. Krupps' Germania

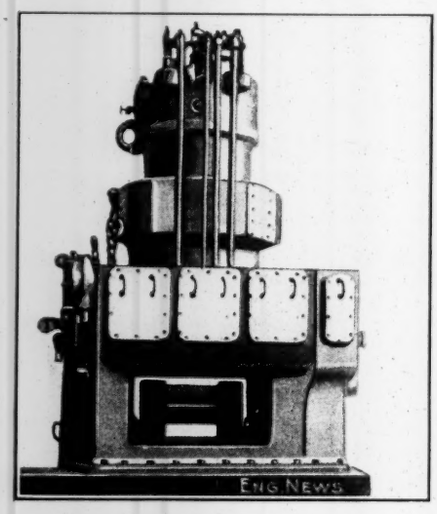


FIG. 8. SINGLE-CYLINDER, DOUBLE-ACTING TWO-STROKE CYCLE ENGINE, 1200-HP., 1911

Works, cylinder units of 2000 hp. double-acting two-cycle are also being tested at present; also at Sulzer's Works a single-acting two-cycle cylinder of 2000 hp.

From motives of prudence, the various navies which are now fitting some large warships with Diesel engines started with one Diesel only out of the two or three engines on board; the Diesel works alone when the ship is running at normal speed, but for high speed, steam is used as an auxiliary. It is evident that larger warships will not be fitted solely with Diesel engines until practical tests on the high seas have proved to be completely successful.

Conclusions—As will be seen from this historical summary, countless different types of Diesel engines have been so developed that it has become very difficult for even the expert to choose between them. Today, if a new firm is about to manufacture Diesel engines, it is almost impossible to give them sound advice as to the type and size they should choose from this bewildering variety. Development is proceeding so rapidly at present, that, within a few months, opinions even on important points may easily be changed.

Still, the author believes that this period of chaotic production will soon be over. At present it is generally agreed that the four-stroke cycle engine from 5 up to 600 hp. may be regarded as the exclusive type for stationary plants; but it will probably not remain so much longer in spite of its perfection, in view of the development of the two-stroke cycle engine, especially that of the double-acting type.

Although this engine may never equal the four-stroke cycle engine as regards thermal efficiency, its initial cost is so much lower than its slightly higher fuel consumption will be more than counterbalanced by the greater interest and amortization on the higher-priced four-stroke cycle engine. When this stage is reached, the question is simply one of economy. In the author's opinion the two-stroke cycle engine will thus soon make headway for stationary plants. It will therefore be necessary to produce from the various systems of two-stroke cycle engines a simple standard type, with which the more complicated types will not be able to compete. It is the author's belief that this simple standard type will make its appearance very soon, and that thus the Diesel engine movement will leave the unsettled stage and enter on a period of quiet expansion.

APPENDIX I. SUITABLE OILS

The Swiss fuel-testing laboratory at the University of Zürich, under the direction of Professor Constam, decided to undertake the examination of the qualities and composition of all liquid fuels which can be used for Diesel engines.

From tests and examinations already made, power oils have been divided into the following three classes:

1. Normal oils which can always be used:

(a) Mineral oils freed from benzene (gas oils)	Hydrogen over 10%, Calorific power over 10,000 cal. (39,680 B.t.u.), No solid impurities.
(b) Lignite tar oils	Hydrogen over 10%, Calorific power over 9700 cal. (38,489 B.t.u.).
(c) Fat oils from vegetable or animal sources, such as earthnut oil, castor oil, fish oils, etc.	Scarcely any researches have been made on these. Earthnut oil has 11.8 per cent. hydrogen, and calorific power 8600 cal. (34,124 B.t.u.).

2. Oils which can be used only with the aid of special apparatus:

(a) Pit coal-tar oil.

(b) Vertical-oven, water-gas and oil-gas tars, probably also coke-oven tars, the tests on which have not yet been completed.

General characteristics:

Hydrogen not over 3 per cent.;

Amount of free carbon not over 3 per cent.;

Residue on coking not over 3 per cent.;

Calorific power not under 8600 cal. (34,124 B.t.u.).

3. Oils which cannot be used:

Tars from horizontal or inclined retorts.

It must not be understood that these will not be used in Diesel engines under special conditions; but, on the whole, the above classification is accurate in the present state of development of the Diesel engine.

APPENDIX II. LIST OF VESSELS PROPELLED BY DIESEL ENGINES

(Built or under construction up to November, 1911; and compiled from publications and private sources.)

As a good many firms maintain strict secrecy about their work in this direction, and as the information obtainable about naval ships is both scarce and unreliable, the lists are not complete. In any case the figures are minima.

(a) Oil-tank Vessels (21)—Of these there are:

12 Russian: On the Volga and the Caspian Sea, principally transporting oil for Messrs. Nobel Brothers, St. Petersburg. The largest of these vessels is the "Djelo," 5000 tons displacement, 1000-1200 hp.

4 German: For the German-American Oil Co. (Standard Oil Co.). Largest vessel, 15,000 tons displacement, 3500-4200 hp. In construction at Messrs. Krupps' Germania Works. The vessel will be constructed on the Isherwood system, and is to contain 22 tanks.

3. Dutch: For different oil companies, one of which is the Anglo-Saxon Petrol Co., London. The largest vessel is 9300 tons displacement and 2200 hp.

1 English: For Messrs. Furness, Withy & Co., Hartlepool. The ship, 3150-ton cargo boat, is being built by Sir Raylton Dixon & Co., of Middlesbrough, and the engines—800 b.hp. "Carels-Westgarth," two-stroke engines with four cranks—are by Messrs. Richardsons, Westgarth & Co., of Middlesbrough.

1 American: For Canadian Lakes, for Standard Oil Co., New York.

It is known that Messrs. Nobel, of St. Petersburg, are gradually converting their whole fleet on the Volga River and Caspian Sea, consisting of 50 to 60 ships of different sizes, into Diesel-engined vessels. It is not known how many of them have already been thus converted.

(b) Tugs (37)—Of these most (about 22) are Russian, for use on the Caspian Sea and the Russian tributaries.

The remainder are for various countries; namely, Chile, Italy, Sweden, Roumania, etc.

(c) Motor Sailing Vessels (8)—Of these two French boats are the most noteworthy:

French: (1) The four-master "Quevilly," with about 600 tons displacement and 600-700 hp. (2) The five-master "La France," the largest sailing vessel in the world, with about 11,000 tons displacement and 1800-2000 hp.

1 German, 1 English, 1 Dutch, 1 Swedish, and 1 Italian motor sailing vessels.

(d) Merchant Vessels (about 43) (Freight, Passenger, and combined Freight and Passenger Vessels)—Of these:

9 are Russian, including: six passenger vessels on the Volga, about 2000 tons displacement and 1200 hp.

7 German, including: one vessel, built by Blohm and Voss for the Hamburg-American Line, of 9000 tons displacement and 3000 hp. One vessel for Hamburg-South America Steamship Co. of 6000 tons displacement and 850 hp.

7 Scandinavian, including: three vessels for the Danish-East Asiatic Co. of 2500-3000 hp.

4 Dutch, 3 English, 2 Swiss, 2 Congo Free State, and the others.

Most of these vessels, especially the larger ones, will not be put in service until 1912. Of the Russian passenger vessels a good many are already in operation.

(e) Fishing Boats (14).

(f) Miscellaneous (about 16)—Of these:

3 are Russian, including: one private yacht, 200 hp., and two for the Russian Minister of the Interior.

3 French: Private yachts, including one of about 400 tons displacement and 400-500 hp.

2 German: The lightship "Hamburg" and the test ship "Bremen."

1 Norwegian: "Fram," exploring vessel for the South Pole, Captain Amundsen, 380 tons capacity and 180 hp.

(g) Submarines (about 110-115), including, as far as can be ascertained, up to the end of 1910:

About 60-70 French, of 390-800 tons displacement and 600-5000 hp.; about 13 Russian, 13 English, two Dutch, two Danish, one Norwegian, one Swedish, one American of 1200 hp., two Italian, two Austrian.

It is probable that the number of vessels has been considerably increased in 1911, and that a large number will be added in the future. Various countries are not mentioned in the list, for instance, Germany, Japan, the South American States, etc. It is almost impossible to publish a list which is absolutely accurate, owing to the secrecy about the number of vessels in construction and the kinds of engines used on them.

(h) Warships (about 20-30):

Here again it is impossible to give accurate figures, as the information published is very scarce and contradictory. It is, however, known that several navies are experimenting with Diesel engines on a large scale. The following are especially noteworthy: A great number of gunboats and a few mine-laying boats for the Russian navy. Also one French, one English torpedo-boat destroyer, and one Italian.

(i) Small Boats (about 15-20):

In the list of navy vessels, although they are not strictly men-of-war, must be included the small boats such as pinnaces, and special boats, of which about 15-20 are destined for the German, Swedish, English, Argentine and Russian navies.

SUMMARY

(a) Oil-tank vessels	about	21
(b) Tugs	"	37
(c) Motor sailing vessels	"	8
(d) Merchant vessels, freight, passenger and combined vessels	"	43
(e) Fishing boats	"	14
(f) Miscellaneous	"	16
(g) Submarines	"	115
(h) Warships	"	30
(i) Small boats	"	20
Total		304

APPENDIX III. BRIEF RESULTS FROM SOME VESSELS PROPELLED BY DIESEL ENGINES

(a) Oil-Tank Vessels

Russian Oil-Tank Vessel "Vandal":

Put in commission 1904. 1150 tons displacement, 360-450 hp. The first oil-tank vessel built for the Volga and Caspian Sea. Reversing (electric) from full speed ahead to full speed astern in 8-10 seconds. Cost for repairs, lubricating, and cleaning for the working year 1906, M.7440 (£364). Sailing radius, unloaded, 13,000 sea miles; loaded, 12,000 sea miles. Mileage in 1905—21,300 km. (11,472 sea miles); 1906—22,400 km. (12,073 sea miles).

Dutch Oil-Tank Vessel "Vulcanus":

Put in commission in the summer of 1911. 2500 tons displacement, 500 hp. Fuel consumption for 100 English sea miles, 1000-1100 kg. (2204-2425 lb.). Daily crude-oil consumption 2½ tons for full load. Saving in cost of fuel as against steam engine, 50 per cent. Voyage Rotterdam-Stockholm in July, 1911: 735 sea miles in 100 hours with cargo of 1000 tons of oil and at a speed of 8.5-8.9 knots. Fuel consumption 8½ tons. The "Vulcanus" has already made a very successful voyage of 32 days' duration to the Black Sea and back, and numerous voyages from Holland to Sweden and England.

(b) Tugs

Russian Tug "Jakut":

Towing capacity 4000 tons, 320 hp. The engines have already worked satisfactorily for two years. The maneuvering power is better than with steam engines.

German Tug "Fortschritt" in Hamburg Harbor:

150 hp. Has also made very stormy voyages on the open sea and carried fuel for eight days. Gain in length one-third over a steamer. Gain in weight of machinery about one-fourth over steam plant. Weight of fuel only 20-25 per cent. of weight of coal for the same power in a steamer.

"Frerichs":

Towing capacity 2200 tons, 200 hp. Maneuvering power same as in a steam vessel. The vessel pays the same insurance premium as a steam vessel. Owing to the absence of boiler and coal bunkers, there is space for the accommodation of 20 passengers. Owing to the absence of the boiler plant the stern of the vessel was made smaller, so that the vessel was more easily handled and the turning circle was diminished. Thirty maneuvers can be carried out in one hour without a change in the air pressure in the starting tanks. With the quantity of air stored in the starting tanks 60 maneuvers can be carried out in succession. A starting tank holds 250 liters (55 gal.), and when completely emptied the pumps can fill it in 15 minutes.

(c) Motor Sailing Boats

"Quevilly":

About 6500 tons displacement, 600-700 hp. on two propellers. The propellers can be uncoupled when using sails only, and their resistance when running light causes a loss of speed of ½ knot. The first ship to cross the Atlantic.

The vessels can enter harbors without the help of tugs. The vessel

takes up its fuel in New York for the double journey at a price of 32 M. (31s. 4d.) per ton, or 6 Pf. (0.7 penny) per e.hp.-hour.

"La France":
Largest sailing vessel in the world. 10,730 tons displacement, 1800-2000 hp. Sail area 6500 m² (69,966 sq.ft.). Will run between France and New Caledonia, and was launched on Nov. 16, 1911.

(d) Merchant Vessels
(Freight, Passenger and Combined Freight and Passenger Vessels)

"Rapp" and "Snapp":
2 small merchant vessels cruising in the Swedish waters. Cargo capacity 300 tons, 120 hp. The engines run for long periods at 55-60 revolutions, although the normal number of revolutions is 300.

"Toiler":
First Diesel sea-going vessel. Cargo capacity about 3000 tons. 360 hp. The steering is controlled by compressed air. The cabins are warmed by hot water heated by the exhaust from the engines. First voyage from the Tyne to Calais with a cargo of coal was made in the summer of 1911 in very bad weather. Oil consumption 1.65-1.75 tons in 24 hours. A steamer of the same size consumes 8-9 tons of coal per day. Saving in cost of fuel as compared with steamer 50 per cent. Gain in cargo capacity 60 tons. Voyage to North America in September, 1911. Fuel consumption, two tons per day. Saving in cost of fuel as compared with steam plant $11 (45s.). Saving in labor $5 (20s. 10d.) per day. Maneuvering power proved to be satisfactory.

Vessel of the Hamburg-American Line:
9000 tons displacement, 3000 hp. Gain in weight and space as compared with a steam plant of the same size, 40-50 per cent.

(e) Fishing Boats

"Ewersand":
German herring boat, built by Frerichs in Bremen. 254 tons displacement, 90 hp. Gain in cargo capacity as compared with steam fishing boat 25 per cent. Can take up 750 casks of herrings instead of 600. First voyage in September, 1910, lasted five weeks. Consumption of crude oil, three tons as against 20 tons of coal for steamer. Homeward journey in 75 hours without a stop, in a high sea. On its arrival at the end of October, 1910, three tons of crude oil were still unconsumed. Very favorable results, and consequently an order for ten more similar fishing boats was placed.

(f) Miscellaneous Boats

"Fram" (South Polar Ship):
It is the old North Polar ship "Fram" fitted with Diesel engine. Gain through replacing the steam engine by Diesel engine: In engine space 45 per cent.; weight of engine 60 per cent.; weight of fuel 80 per cent.; space for fuel 85 per cent. Several years' supply of fuel can be stored. Of 380 tons cargo capacity 100 tons were previously required for the coal storage. The "Fram" sailed for six months from Christiania to the South Polar regions without touching land and without reporting. During the voyage in the Antarctic the engine worked for 2800 hours without giving any trouble.

Letters to the Editor

Life and Maintenance Cost of Freight Cars

Sir—Referring to the table on p. 456 of your issue of Mar. 7, 1912, showing average life and cost of maintenance of freight cars, I would call attention to the exorbitant cost of such repairs on the Illinois Central R.R. during the years 1909-1910. It will be remembered that extensive frauds were discovered in the car repairs of this railway, involving the payment of excessive repair charges. The reduction in cost of Illinois Central car repairs, shown by the table referred to, from $134.01 per car in 1910 to $91.99 in 1911 is evidence of the correction of these frauds, and shows that the excessive figure for the 1910 repairs should not be used for comparison.

Increasing importance is being attached to the statistical records of railway operation and this affords a very striking instance of the way in which such records might have been used to discover at an earlier date a very serious evil. Anyone interested in the operation of railways could not run over this table without discovering instantly that something was wrong with the Illinois Central R.R., and it would then be the duty of an interested official to locate the cause of this great excess in cost beyond that reported by other railways.

ALBERT J. HIMES,
Engineer of Grade Elimination,
N. Y., C. & St. L. Ry.
Cleveland, Ohio, Mar. 9, 1912.

The Visit of the German Technical Commission to the United States

Sir—In the city of Munich, Germany, there is a remarkable museum, which is known at present to comparatively few American engineers; but which deserves to become the Mecca of those who travel in Europe.

The name of the museum is "The German Museum of Masterpieces of Natural Science and the Technical Arts." Its name modestly describes its purpose; but it might justly be termed a museum of human progress; and as the engineer eagerly applies each advance in science to the ever expanding demands of mankind, it is especially a museum of engineering. Every advance in the technical arts is here exhibited in all its stages, from the crudest beginning to its latest modern perfection.

To merely catalogue its treasures would require many pages of this journal. A few examples chosen at random must suffice.

In water transportation, for example, there are shown first the dug-outs of primitive tribes, the war canoes of darkest Africa, the basket coracles which date back to Babylon, the outrigger crafts of Ceylon and then on through various stages of the world's progress, up to the palatial liners and the battleships of today. Every known vehicle of marine travel is to be seen either in original examples or in beautiful and accurate models.

In land transportation, every method of construction is to be seen from the footpath of the savage, through the permanent structures of the Romans, to the railways and mountain rack roads of today, the constructions being shown by models, drawings, paintings, and by actual parts where possible. I found here a section of plank road built as one of their Pontes Longæ by the legions of Cæsar and recently dug up, perfectly preserved, from the morasses of Northern Germany.

Aëronautics is one of the latest divisions installed, but occupies some eight or ten rooms. It begins with drawings of crude devices described in ancient writings, reproduces Leonardo da Vinci's plans for his motorless monoplane, the fire balloons of the Montgolfier Brothers, contains the actual gliders used by the first martyr in the cause, Lilienthal, and a succession of later models of air craft of all kinds, with full sized machinery now in use. There are great thaumatropes in which the actual flights of various birds are shown at any speed desired by the student.

The collections of this museum were first housed in a former art gallery. As they outgrew this, the Bavarian government furnished the large barracks and stables of a regiment of cavalry, but both overflowing, a fund of several millions was subscribed by corporations and individuals throughout Germany, and a mag-

nificent building is now nearing completion on an island in the Isar (which still "rolls rapidly") near the center of modern Munich.

The moving spirit in this great enterprise is Dr. Oscar von Miller, the president of the Verein Deutscher Ingenieure, who heads a commission which will arrive in New York on Apr. 6, for a tour through the industrial districts of the United States.

The other members of the commission are: Dr. Count von Podewils, Duerniz; the Lord Mayor of Munich, Dr. von Borscht, Privy Councillor; Prof. Dr. W. von Dyck, Privy Councillor, Rector emeritus of the Technical University of Munich; Mr. Gelius, architect of the museum. Dr. Rudolph Diesel, who has had much to do with the development of the museum, but is not a member of the commission, accompanies them.

These gentlemen are coming to America to study the important achievements of American engineering work, and the American Society of Mechanical Engineers is arranging for their reception at a special meeting under the management of the New York local committee and the Gas Power Section. This meeting is to take place in the main auditorium of the Engineering Societies' Building on the evening of Apr. 9 and all engineers are invited to attend. Dr. von Miller will deliver an address, explaining fully the work of the Museum and this will be followed by an informal reception at the Society's rooms.

E. D. MEIER.

11 Broadway, New York City,
Mar. 28, 1912.

Re-Rolled Rails as Concrete Reinforcement

Sir—In your issue of Feb. 15, 1912, p. 305, E. W. Stern "sounds a note of warning" against the use of concrete reinforcement made from old rails.

I wish to express my approval of the position taken by Mr. S on this matter, for I believe it to be a serious one. It is fully as important that the reinforcing metal be above suspicion as the cement. Experienced structural engineers know that bar stock as produced from re-rolled T or other rails in the past has not been as reliable in quality as that produced from new ingots. This variation has probably been due to various causes, some of which are, the difference in chemical composition of the head and base of the rail; the fact that many rails known as "seconds" have been used for this purpose; and the danger that the large amount of corroded surface of the old rails may not always have been eliminated by welding, thereby producing a slag defect running through the bar.

While I was in charge of the Testing Laboratory at Columbia University, I had considerable experience in testing deformed bars made from old rails, and learned very conclusively that such stock was not reliable. Some of it would give an excellent test, but other lots were practically worthless, hence very dangerous to use.

Whether this product has improved in quality during the past three or four years, I am not prepared to say, but considering the many causes that might produce defects, it would seem but reasonable prudence that such material should be used with extreme caution in reinforced concrete where so much depends upon the absolute integrity of the metal. The quality of ductility should be a rigid specification for all reinforcing bars in concrete construction.

IRA H. WOOLSON, Consulting Engineer,
National Board of Fire Underwriters.
135 William St., New York, Mar. 18, 1912.

Sir—I note some discussion in your columns relative to the merits of reinforcing steel made from re-rolled rails, and I want to be placed on record as being thoroughly opposed to such material. My experience has been that the product is very uncertain and I have had occasion to reject a very considerable quantity of bars made from such stock on several different occasions.

I have no doubt that if the heating and rolling is properly done a good bar can be made, in fact, I have seen many such, but, on the other hand, if there is any carelessness or negligence in the manufacture, such bars are likely to be very brittle and unreliable in quality. They will frequently break in being handled or dropped, and I do not consider such material as desirable to be used in connection with reinforced concrete. There are sufficient dangers likely to creep into such construction without taking any chances on the quality of the steel itself.

ROSS F. TUCKER.

35 W. 32d St., New York City,
Mar. 22, 1912.

Sir—I have noticed with some interest the discussion which has been going on in your valuable publication lately regarding the question of re-rolled iron or steel.

Those who have had any experience with this material will, I think, admit that it is very uncertain in its character and, therefore, to be used only with considerable care and only for certain kinds of work.

I have had considerable experience with re-rolled material in connection with reinforcing bars for concrete construction, and, while I know that some of it is of good quality and character, I have seen some which would untwist and disintegrate very much like a piece of rope, when bent or even hammered. Such material is also apt to be brittle, and rupture badly under ordinary bending.

It seems to me that the unlimited use of such material would be a great mistake.

G. E. ESCHER, President,
White Fireproof Const. Co.
286 Fifth Ave., New York,
Mar. 23, 1912.

Overloading Flat-Slab Reinforced-Concrete Floors

Sir—Possibly a little information relative to the full loading of flat plate and wall panels may answer the queries of Mr. Godfrey in ENGINEERING NEWS, Feb. 29, 1912, p. 404.

On a little building, used for storage purposes, I had guaranteed the construction for a 300-lb. per sq.ft. working load over the full area and a test load of twice this amount over any panel. Nearly two years after the building was completed, my attention was called to the fact that they were loading this building very heavily indeed, and I personally investigated it. I found three consecutive wall panels loaded with 17 sacks high of sugar, piled solid over the entire area, which had stood on the floor for three months. On calculating this load, it seemed that there was a little less than 800 lb. per sq.ft. over the full area, and while this load had remained on the floor for between two and three months, the owners were very tartly advised that there were limits even to a good thing, and that the sooner they took off five sacks from the pile and reduced the load at least to not more than double that for which the building was designed, the sooner they would relieve themselves from what might prove to be criminal liability should trouble occur.

The panels loaded were wall panels, with no columns or cantilever heads next the wall, the slab being built to rest on walls and spanning from column to wall.

Such cases of overloading are common in the ordinary storage warehouse rated at 200 to 250 lb. per sq.ft. capacity.

Mr. Godfrey asks: "Does it not look like taking long chances on the probability of a building receiving its full load from wall to wall along a row of panels?" As a commercial condition this is not ordinarily as bad as we have to go against. If we are fortunate enough so that the owner does not *more than double the load* there is no occasion with the "mushroom" system, at least when properly executed and thoroughly hardened, to lose any sleep over it. While the writer did throw the scare, as it were, into the owners of the building referred to, his fear was not that there would be a sudden collapse, but rather that they would overload the floor to such an extent that a considerable permanent deflection would result with some weakening of the construction.

The resistance of a multiple-way reinforced slab is well brought out by dy-

namic test incidentally applied to a roof slab, about 22 ft. square and 7 in. thick. A water tower was constructed over this roof slab with steel supports, which gave way under wind, dropping 50 tons of water and the tank 10 ft. onto the middle of the roof slab, which was designed to carry 100 lb. per sq.ft. The slab was somewhat dented, slightly cracked, and eight or ten of the ⅝-in. reinforcing bars were elongated and reduced in section, but they carried the load and absorbed the shock, saving the elevator machinery and the side of the building. The water going over the side demolished the ends of three box cars and broke down the awning over the shipping platform of the building.

Mr. Godfrey seems to possess a deep-rooted antipathy to circular stresses and the consideration of the useful work they actually perform in carrying the load. In order to eliminate this "objectionable" efficiency he suggests a design which is a cross between the radial beam of Seely and the true flat plate. Evidently when a concealed radial beam is employed it should be figured as a beam, but double the steel is required and 50% more concrete to get the same strength; hence commercial feasibility is lacking in the proposed modification. This statement is based, of course, on the assumption that the well known advantages of the flat slab in simplicity of forms, better light, reduced cost of sprinkler system, etc., are to be maintained.

[Mr. Godfrey did not suggest this crossed-beam construction as a commercial possibility, but merely referred to it as bearing upon the theoretical action of a flat plate.—ED. ENG. NEWS.]

Suppose we put in beams in one direction from column to column, leaving the construction otherwise just as though to carry the load without the beams. Then Mr. Godfrey asks: "Would the slab so supported on posts be weakened by introducing supporting girders in one direction?" "Would the slab not then be a simple slab amenable to the laws set forth in the theory of flexure?" These questions seem to show Mr. Godfrey's lack of familiarity with the ordinary theory of flexure and least work. The slab will be strengthened somewhat by the addition of the girder. The load (under the well known theorem of rigidities) would divide itself between the slab and the beam strictly in proportion to the rigidity of the slab under load without the beam and the increase of rigidity of the combined beam and slab construction. The mere addition of a beam to a "mushroom" slab would hardly metamorphose the construction to a one-way reinforced slab to accommodate the ideas of even such an ingenious and interesting theorist as Mr. Godfrey.

While the foregoing proof from the principles of least work will be apparent at once to those who have given consideration to this method of the determination of secondary stress, etc., the above explanation may not be as clear and convincing as one founded directly on the ordinary theory of flexure.

Treating the plate as we do along the line of the flat-plate theory and considering the belts of rods in four directions to have the same maximum stress, we can get a line on the relative deflection of the center of the panel diagonally and the center of the panel directly from column to column by the ordinary theory of flexure. Thus by mechanics the general formula for deflection for a given working stress is

$$\Delta = \frac{nl^2S}{mcE}$$

n and m being coefficients, l the span, S the working stress, E the modulus of elasticity, c the distance of extreme fiber from neutral axis. In other words, Δ varies as $\frac{l^2}{c}$, which we might, of course, modify to apply to the reinforced combination rather than to the beam of homogeneous material. This refinement is unnecessary to bring out the point under discussion. The deflection varying as $\frac{l^2}{c}$, then the deflection in the center of a panel diagonally would be double the deflection in the center of a panel directly between columns where the panel is square, and this theoretical relation is found to accord almost exactly with the measured deflections of the "mushroom" system under test.

It is evident then that the curvature of Mr. Godfrey's cylinder is a very peculiar surface indeed if we are to fit it to the condition that an element of a cylinder, parallel to its axis, is a straight line. The element of Mr. Godfrey's cylinder, which he assumes would be the surface after deflection, would be a sinusoidal curve and varying from the straight line exactly as far as his assumptions differ from the practical conditions presented by the structure.

Referring again to the statements of F. L. Condron in ENGINEERING NEWS, Feb. 8, 1912, p. 262, regarding flat-slab floor deflections under load, I would like to call attention to a loading test on the stock house of the Hamm Brewing Co., a heavy building rather than one of the lighter class, which gave a deflection of $^{3}/_{64}$ in., or a little less than $^{1}/_{5000}$ of the 32-ft. diagonal span, under the 200-ton test load.

C. A. P. TURNER.

Minneapolis, Minn., Mar 16, 1912.

Notes and Queries

In the article on "Water Supply Projects in connection with the New York State Barge Canal," in our issue of Feb. 15, p. 281, credit was inadvertently omitted to Mr. A. D. Sanderson, who did much of the detail work of preliminary design.

The 328-ft. reinforced-concrete arch across the Tiber at Rome (the Ponte del Risorgimento) is not provided with expansion joints, according to an authoritative article in the "Annales des Ponts et Chaussées," Jan-Feb., 1912. In our descriptive article of the bridge (Nov. 30, 1911, p. 641) we stated that the descriptions of the bridge differed in this point, but from the present advice it appears that the bridge is continuous from abutment end to abutment end, a distance of 148 m. (486 ft.).

In the article "Results of Tests on Three Rotary Air Compressors" in our issue of Feb. 29, 1912, a 4000-hp. compressor at Johannesburg was described as having a "capacity of 1,250,000 cu.ft. of free air per minute" and an "energy consumption per 100 cu.ft. of free air of 0.301 hp." Comparison of other figures in the article shows that these statements should have read "1,250,000 cu.ft. of free air per hour" and "0.301 hp.-hr." respectively. Also an air pressure of 114 lb. was made to read 114,000 lb.

C. L. Annan, Office Engineer of the Department of Public Works, St. Paul, Minn., who in 1883 was Office Engineer of the Chihuahua division of the Mexican Central Ry., sends the following addendum to the life of the late Lewis Kingman, briefly sketched in our issue of Feb. 8, 1912:

After the building of the Sonora Ry., William R. Morley was the Chief Engineer of the Chihuahua division of the Mexican Central Ry., in November, 1882. He was accidently killed the following month, while returning from a reconnoissance in the state of Zacatecas. John E. Early succeeded him as Acting Chief Engineer until the appointment of Lewis Kingman in April, 1883. Holbrook, Morley, Early and Kingman were all associated under A. A. Robinson, Chief Engineer of the Atchison, Topeka & Santa Fé Ry., in the late seventies.

Our statement that Mr. Kingman succeeded Howard Schuyler as Chief Engineer of the Mexican Central Ry. was, therefore, not strictly correct as Mr. Kingman did not become Chief Engineer of the entire railway until some years later.

J. M. A., Los Angeles, Calif., sends us a clipping from the Los Angeles "Express," containing another example of a newspaper "scare story" concerning the Panama Canal. The article purports to be an interview with "a well known engineer who is thoroughly familiar with the Canal Zone."

The degree of his familiarity may be judged from the following excerpts:

The Culebra mountain, through which the cut is made, is certain to slide more or less all the time, for in formation it is a strata of blue clay and water. In reality the Culebra mountain is a silicate; it is constantly moving. The mountain extends from Honduras into Mexico.

My judgment is that the bulging up of the cut, if there is such a bulging, is due to seismic causes, for in Spanish Honduras, at La Cieba, is a volcano that is active at all times, and therefore this is the real cause of the trouble.

At Port Abello, where De Lesseps intended to start the canal, the Culebra mountain cannot be seen and could the canal have begun there much of the difficulty now encountered would not have been met, but he was thwarted in his efforts by a New Yorker named Ryan who, prior to the beginning of the original work, leased all the ground about the entrance to the harbor there, and when they were confronted with the leases the French people were ready to work and finally forced to make their start from Christobal Colon.

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Engineering News

Extract from a Traveler's Notebook:

The principal scenery observed from the car window on the journey between New York and Philadelphia consisted of billboards, mostly atrocious.

In these days when the rights of everybody, men, women, children, horses, dogs and cats, are protected by law, is it not time that some statute was passed protecting the right of the traveler to have the landscape which he would like to enjoy on his journey preserved from disfigurement? The March *Bulletin of the International Railway Congress* records that action has been taken in Germany to protect the scenery along certain railway lines from disfigurement. An order was issued on Apr. 10, 1911, by the President of the National Board of Police, prohibiting the display of billboards, posters and other advertisements which interfere with the scenery anywhere within 984 ft. from the right of way. This prohibition applied to the Berlin-Halle line, and the Juterbog-Truenbrietzen line. Existing billboards on these lines were required to be removed before May 15, 1911.

This order of the National Police was based on a Prussian law passed in 1902, authorizing the National Police, in order to prevent fine scenery from being disfigured, to prohibit the display of advertisements in designated places outside of municipal boundaries. Inside towns or cities, the local authorities have jurisdiction over all advertisements.

The agitation in the United States in favor of federal appropriations to build good roads is duplicated in Canada, where a bill is pending in the Dominion Parliament authorizing the Dominion Government to give financial aid to the several Provincial governments in the construction of highways. In the debate on the bill on Mar. 18, Sir Richard Cartwright is quoted as follows by the *Toronto Globe:*

There is no more insidious corruption than the bribery of whole constituencies by Government promises of public works. The title of the measure should be amended and read, "An act to make the British North America Act so much waste paper and to provide a permanent corruption fund for the Government of the day."

If there was one thing the British North America Act was clear upon, it was that local works and undertakings should be left to the control of the Provincial Legislatures.

Under this scheme it will be impossible to do justice between the Provinces. He quoted figures to show that the annual tax on the people of the Maritime Provinces was about $3 a head per year for customs and excise, while the people of Manitoba and British Columbia paid $18 a head on the same account.

"I warn the House against this measure on every possible ground. I say it is at once impolitic, unjust and in the highest degree unconstitutional. We committed an act of supreme folly on Sept. 21, 1911, by refusing the offer of free trade in natural products with the United States, and since then we have had as sharp an object lesson as any country ever had in the present condition of affairs in the Northwest. The Northwest ask some compensation for the loss of their natural markets, and by this bill they are being offered the privilege of paying for the roads and bridges of other Provinces 3000 miles away."

Twenty-five years ago, when the Interstate Commerce Law was enacted and the Interstate Commerce Commission was created, ENGINEERING NEWS hailed the new movement as a long step forward in wise and beneficial railway regulation. How important and how necessary was this establishment of federal control over railways is probably realized even today by a comparatively small proportion of railway officers.

A notable example of the necessity of federal regulation of railways is furnished by the recent decision of the Interstate Commerce Commission in connection with relative railway rates in Texas and in Louisiana. The clear-cut issue presented in this case was the power of a state railway commission to compel the railways under its control to make especially low rates to benefit the trade of commercial cities within its territory in competition with rival cities in neighboring states. The Interstate Commerce Commission found that as a result of the rates prescribed by the Texas Railroad Commission, the cities of Dallas, Houston and other jobbing points in Texas had an unfair trade advantage over Shreeveport, La. If the railways were subject to state regulation alone, it can readily be seen where such regulations would lead. Each state railway commission would try to protect the commercial interests of the cities in its own state, regardless of the interests of rival cities in other states and regardless also of the effect on railway revenues. Nor would state railway regulation stop there if the state's authority were supreme. There is a strong tendency in some states for the state to place some tax or embargo on the natural products of the state when sent outside its borders. If state railway commissions had the power to raise as well as to lower rates without federal interference, a way would then be open whereby the different states could obstruct the movement of raw materials beyond their borders.

The majority of the commission, in its opinion rendered in this case, holds in emphatic terms that where state and

interstate railway regulation are in conflict, the former must give way. That this decision will be upheld by the Courts if appealed, there can hardly be a question. If the United States is to continue a single nation and not a federation made up of half a hundred commercially independent commonwealths, then the supreme control of the federal government over interstate commerce must not be impaired.

The River and Harbor Appropriation bill, as reported by the House committee, provides for an expenditure of $26,200,000 in round numbers. The committee says that this is the smallest amount carried by any River and Harbor bill presented since 1894. It must be remembered, however, that the policy of annual appropriations for rivers and harbors was only adopted in 1910. Previous to that time the appropriations made in a River and Harbor bill had to last for two or three years. As the next session of Congress is a short one, terminating on Mar. 4, 1913, the present appropriation has, as the committee states, to provide for only eight or nine months' work. Therefore, if the bill were passed in its present form, it would mean an annual rate of expenditure by the United States on rivers and harbors of about $35,000,000 per annum, which may be compared with an average of about $25,000,000 per annum for the ten years from 1894 to 1904.

Of the total amount provided for the bill, nearly $10,500,000 is for work on the Mississippi, Missouri and Ohio Rivers. Among the schemes of very doubtful merit, for which the bill makes provision, are the Brazos and Trinity River slackwater navigation in Texas, which receive $650,000, although the engineers in charge of both these works have recommended that they be reëxamined to determine whether it is worth while carrying them forward under present conditions. The same amount is provided for work in Tennessee on the Cumberland and Tennessee Rivers.

A new provision in the bill requires that the engineers examining projects shall report upon water terminal and transfer facilities in connection with any project, or any waterway under improvement. Engineers are also required to report as to connections between water terminals and railways and as to contracts between rail and water carriers for interchange of traffic and division of rates.

A Standard Guarantee for Street Paving Contracts

The Association for Standardizing Paving Specifications, at its recent annual convention in New Orleans, adopted a standard form of maintenance guarantee for street-paving contracts. As many city engineers are required by the city authorities to draw paving contracts accompanied by a certain number of years' guarantee, there is no particular objection to the preparation of a standard form. As one critically reads this guarantee, however, the strongest impression made is that the best kind of guarantee is no guarantee at all. The guarantee recites that at the end of five years from the time the roadway is opened for traffic, "the pavement shall be in good, serviceable condition and free from defects that will impair its usefulness as a roadway, ordinary wear and tear excepted." Who is able to draw with certainty that fine hair line which marks the boundary between "a defect that impairs usefulness as a roadway" and ordinary wear and tear? How broad and how deep must a depression in the pavement be to be classed as a "defect"? It is a comparatively easy task for an engineer to say whether a newly laid pavement is built in a first-class manner and in accordance with specifications; but to attempt to reduce to definable terms the condition in which a street pavement subjected to heavy traffic must be in after five years of use—that seems to us like attempting the impossible.

In order to make the guarantee in any way workable, it has to be hedged about with particulars as to openings made through the pavements, the building of street-railway tracks in the street, etc. It is necessary furthermore that the contractor or some substitute shall practically live with the pavement during the five-year period and undertake all repairs and replacements made necessary by street excavation.

It is our opinion, and we believe it is the opinion of all progressive engineers in charge of street-paving work, that this is the wrong way and the most expensive way to take care of a city street. The way to have paving laid at the lowest cost is to provide a first-class specification, compel the contractor to live up to it, and when the pavement is laid, pay him his money in full. The best way to make repairs on street paving is by the city's own forces under direction of the city engineer.

Non-Recognition of Municipal Experts in Commission Plan City Charters

The remarkable spread of the commission plan of city government, which now includes over two hundred cities, located in 34 states (see pp. 638-9) calls for a note of warning against over-confidence in one of the strongest claims of the commission plan on popular support. This claim is that by dividing all municipal activities into five groups and putting one of the five elected councilmen in charge of each group, and giving him the title, Commissioner of Public Works or Commissioner of Health and Safety, all the business of the city has been placed in the hands of municipal specialists.

A man cannot be made into an expert by giving him a title, not even when it is bestowed by popular vote. The most that this division of duties does is to fix responsibility. It may not even do this if the decisions of each of the five councilmanic department heads is subject to the approval of the four other commissioners.

In so far as the commission-plan cities do get expert service, it is generally through sub-department chiefs: men under orders from the councilmanic heads, if not the whole council; men liable to be looked down upon by their superior officers and held in relatively low esteem by the voters. This does not tend to secure a high type of technically trained men as expert municipal administrators.

The case is made worse by the common though not universal failure of the commission charters to provide an adequate civil-service system, without which there is no assurance of selection or advancement for merit, nor for retention in office during worthy service and good behavior.

We are not arguing against the commission plan, nor against making each councilman a head of a department. We are simply urging that the councilmanic department-head feature ought not to give a false sense of security. Charters to cities for a commission form of government should contain adequate civil-service provisions and these provisions should be strictly enforced.

We do not mean, by any means, to hold up the civil service as a panacea. The real burden of our note of warning is that the failure to make adequate provision, and in many cases any provision worthy the name, for securing the service of real municipal experts seems to be one of the weakest points in the commission plan of city government, in the form generally adopted.

What Is the Diesel Engine?

We give much space in this issue to a paper by Dr. Rudolf Diesel, of Munich, Germany, summarizing the present status of the Diesel engine. It will probably surprise most American engineers, even those who are posted on the recent progress made abroad in the application of the Diesel engine to marine propulsion, to learn that there are now over 300 vessels afloat or under construction equipped with Diesel engines, and that a considerable number of these are good-sized ocean-going ships.

There has been no development in the whole field of mechanical engineering since the invention of the steam turbine, of as great importance as that which has taken place in the construction of Diesel engines during the past four or five years

To this recent development the United States has contributed absolutely nothing. Engine builders of such countries as Italy, Russia, Denmark and Holland have been active in the design and construction of Diesel engines, especially for marine service; but the United States, with all its boasted progressiveness in mechanical engineering, has been almost wholly blind to the importance of this great advance in the field of power development. At the present time, it is true, some half a dozen American firms have begun building Diesel engines; but so far as we know, they are all merely copying European practice.

Certainly a step forward in engineering of such importance ought to be appreciated and understood by every intelligent engineer, in whatever branch of work he is engaged. We suspect, however, that a large proportion of American engineers have no clear idea as to what a Diesel engine is.

It has seemed to us worth while, therefore, to supplement Dr. Diesel's paper in this issue by an elementary explanation of the Diesel engine, and of the reasons why it has become of such great importance in the power-development field.

Beginning, then, with very elementary matters, the internal-combustion engine (which clumsy term is the best we have to designate the various types of gas, gasoline and oil engines) is a machine in which the motive force is the pressure produced by burning a mixture of combustible material and air. In the ordinary gas or gasoline engine, which has become familiar to practically everybody through the world-wide use of the automobile, a mixture of combustible gas and air is taken into the cylinder of an engine at the end of a working stroke and is compressed by the piston on its return stroke. This compressed combustible mixture is fired at the proper time, almost always nowadays by an electric spark produced inside the cylinder. When set off by the spark the mixture explodes, or more properly speaking burns, and produces a large volume of gas at a high temperature which exerts a pressure on the piston, driving it forward on the working stroke. The gasoline engine differs from the gas engine in that the gas for use in the cylinder, instead of being drawn from a supply main or reservoir containing natural or artificial gas, is made as it is needed by the evaporation of a volatile hydrocarbon, known as gasoline in this country, and in England as petrol.

For many years inventors have worked upon the problem of making an engine which, instead of using the highly volatile more or less dangerous and somewhat expensive gasoline, could use instead ordinary kerosene, or some heavier distillate of petroleum, or crude oil as it comes from the wells. Many such oil engines have been designed and built, but they are all of two classes. In the first class the kerosene is vaporized by heat or other means and used to impregnate the air taken into the cylinder, just as the gasoline does in the gasoline carburetor. In the second class the cylinder takes in a charge of air only, instead of a mixture of air and gas. This charge of air is compressed by the return stroke of the piston into the clearance space between the piston and the cylinder head, and at the end of this compression stroke a finely divided spray of oil is injected into this compressed air. This oil spray cannot be ignited by the electric spark, so it is necessary to have a "hot pot," hot plate, or some similar contrivance attached to the cylinder which is not cooled by the water jacket and which is kept hot enough to ignite the oil spray. This hot igniting chamber has to be heated to red heat by a lamp before the engine is started up, but after the engine is running this chamber is usually kept hot enough by the heat furnished at each working stroke of the engine by the combustion in the cylinder.

The first type of oil engine noted above is obviously possible of use only with some distillate of petroleum, such as kerosene. The "hot pot" type of oil engine can use heavier oils, but it has numerous drawbacks. Besides the objections to the use of the external lamp for starting and the delay involved in it, there is the more serious objection that the oil engine is rather wasteful of fuel, and because it does not give perfect combustion requires considerable attention in the way of taking apart and cleaning. It has so far been found impossible to spray oil by any purely mechanical means into fine enough particles so that it can be completely burned in the very brief time necessary for use in an engine cylinder. To get an idea of what is involved in this, suppose an oil engine is to be run at 300 r.p.m. At this rate it will make a working stroke in one-tenth of a second. To give good efficiency the engine should receive and burn its fuel charge while the crank is traveling from the dead center a distance of perhaps 20° on the working stroke, or one-ninth of the total time of the working stroke. An oil engine, therefore, running at the speed above stated, should receive and completely burn its charge of oil spray in $\frac{1}{90}$ of a second.

Taking up now the explanation of the Diesel engine: this engine is operated like the second class of oil engines above described, in that a charge of pure air only is taken into the cylinder and compressed on the return stroke of the piston. Instead of using a compression of 50 to 150 lb. per sq.in., however, according to the practice of other oil-engine inventors, Dr. Diesel carried the compression to 500 lb. per sq.in., approximately. At this pressure the air in the cylinder has a temperature of over 1000° F. Into this body of highly heated compressed air there is then delivered a finely atomized spray of oil, the atomization being effected by a jet of compressed air under a pressure 300 to 500 lb. higher than that in the clearance space of the cylinder.

Engineers who have had experience in compressed-air caissons well know how increase in air pressure stimulates combustion. Experience with fires inside compressed-air caissons has shown the great difficulty of extinguishing a fire once started in such a place. But if combustion is stimulated by ordinary caisson pressures of 20 to 40 lb. per sq.in. it is doubtless stimulated vastly more by the pressure of 500 lb. per sq.in., existing in the clearance space of a Diesel engine cylinder.

Complete and rapid combustion is further facilitated by the fine atomization of the liquid fuel and by its thorough mixture with the air in the clearance space, by the agency of the air jet under pressure of 300 to 500 lb. per sq.in. It is due to the complete combustion and the rapid combustion obtained by this high air pressure and fine atomization of liquid fuel that the Diesel engine owes, in a large part at least, its very high fuel efficiency.

The perfect combustion is not only important because of the high economy thereby attained, but because the engine cylinder does not require cleaning out at frequent intervals as does the "hot pot" type of oil engines. The Diesel engine also dispenses with one of the most troublesome parts of the ordinary gas or gasoline engine, the electric igniting apparatus. It also does away with the carburetor, which is a more or less troublesome adjunct of the gasoline engine.

But an advantage of the Diesel engine of even greater importance is that pure air is compressed in the cylinder, instead of a mixture of gas and air. The gas or gasoline engine has to be designed of sufficient strength to withstand the stresses which may be set up by premature explosion of the combustible mixture in the cylinder. Such premature explosion, or "back firing," may be caused by a glowing spark of carbon adhering to the cylinder head or piston, by an overheated piston, by deposits in the water jacket, allowing the cylinder walls to rise in temperature, and by numerous other causes. In short, there is inevitably a certain amount of risk in compressing an explosive mixture of gas and air in an engine cylinder, and while engine designers attempt to provide for these stresses, their computation is subject to such uncertainties that occasional disasters result. In Diesel engine design, on the other hand, while the maximum stresses are high on account of the high compression carried, they are calculable with fair accuracy. Further than this, the mean effective pressure of Diesel engines on their working stroke is far higher than

that of gas engines, or low-compression oil engines. A much smaller cylinder, therefore, is sufficient for a given development of power.

There is another advantage of the Diesel engine which is only beginning to be generally realized by engineers. This is that the two-stroke cycle engine is put on a par with the four-stroke cycle, or rather for practical purposes it is placed far ahead of the four-stroke cycle.

For the benefit of readers unfamiliar with gas-engine design, we may explain that in most gas or gasoline engines, of which the automobile engine is an example, only one stroke of the piston in four is a working stroke. In a vertical engine, for example, the piston is driven down on its working stroke under pressure of the burning and expanding gases, then on its upward stroke it forces out the burned gases through the exhaust ports, then comes a downward stroke, when the piston draws in a charge of fresh air through the inlet ports, and then an upward stroke, during which the piston compresses the mixture of combustible gas and air, and is then ready to repeat its working stroke.

In the two-stroke cycle engine, the piston makes its working stroke under pressure of the expanding gases, and as it nears the end of this working stroke the exhaust ports are opened, allowing the expanding gases, which are still under considerable pressure, to blow out from the cylinder, which they do almost instantly. The pressure in the cylinder being thus reduced to atmospheric, the inlet ports are opened, and a new charge, which has been put under a moderate pressure of 1 to 8 lb. per sq.in., rushes into the cylinder through these inlet ports, driving the remaining burned gases ahead of it out of the exhaust ports. This process of scavenging the cylinder takes place in an exceedingly brief space of time, while the crank is passing over 20° to 30° at the lower dead center. The inlet and exhaust ports are then closed, and the piston compresses the charge in the cylinder, as in the third stroke of the four-stroke cycle.

Where the two-stroke cycle engine is used with gas or gasoline engines, what is forced into the cylinder at the end of the exhaust stroke is a combustible mixture of gas and air. But if the burned gases are to be thoroughly cleaned out of the cylinder it is inevitable that some of this unburned mixture of gas and air will mingle with the exhaust gases and will be carried out through the exhaust ports before they close. This means, of course, loss of fuel and reduction in efficiency.

It is possible, of course, in large engines, with sufficiently accurate adjustment of the valves, to reduce this loss to comparatively small proportions *while the engine is working on uniform load*, but with variable loading, for reasons which will be apparent on a little study of the problem, the two-stroke cycle system for gas or gasoline engines becomes either too complicated or too wasteful of fuel to be practicable.

Besides the loss of fuel in the two-stroke cycle system when used with gas engines, there is always risk that the entering charge of gas and air may be prematurely fired by mixing with the hot exhaust gases still remaining in the cylinder.

With the two-stroke cycle system applied to the Diesel engine, on the other hand, nothing but air is used for scavenging and charging the cylinder at the end of the working stroke. The scavenging can be made as complete as may be desired, and no fuel will be lost through the exhaust ports, but only air under slight pressure. The advantage of the two-stroke cycle system, when freed from the limitations and disadvantages which attend its use in gas and gasoline engines, are obvious even to a layman. Since the number of working strokes is doubled, a two-cylinder engine will give as smooth a turning moment as a four-cylinder engine working on the four-stroke cycle. The flywheel is thereby reduced in size on the stationary engine, and in marine engines a smooth motion is obtained with a smaller number of cylinders. The weight per horsepower of the engine is also nearly cut in two. This is extremely important because one of the drawbacks in the use of the internal-combustion engine has always been its excessive weight and cost.

It is unfortunate for the progress of the Diesel engine in this country that American manufacturers, and not a few American engineers, have the idea that the chief merit of the Diesel engine is its high fuel efficiency and that it is a very complicated machine. It is a foundation principle of "practical" American shop management that any "complicated" machine must be blacklisted, and only a "theoretical" engineer would be so foolish as to buy a complicated machine just to save a little fuel.

But a very good definition of a complicated machine is a machine you do not understand. The Diesel engine is really no more "complicated" than the gas or gasoline engine, and abundant experience has shown that it gives, if anything, less trouble in operation. And the fact that its fuel economy is higher than that of gas or gasoline engines is for most installations a minor matter. Its great advantage is that it is a complete self-contained machine which takes fuel and converts its stored heat into power in one operation. The boiler plant of the steam engine and the gas producers and all their ruck of auxiliaries are dispensed with. It has in this the same advantage as the gasoline engine; but it uses a fuel which is little more dangerous to handle than coal and costs a quarter as much as gasoline.

But a complete statement concerning the Diesel engine must include its drawbacks as well as its merits. It is proper to inquire what are the disadvantages of the Diesel engine which have caused it thus far to be almost ignored by American engine manufacturers and power users.

One of these is its high cost. With cheap fuel available at nearly every industrial center in the United States, manufacturers have generally hesitated to incur the high cost of Diesel engines in view of the low cost of steam power. The cost of Diesel engines, however, has already been radically reduced in Europe and is almost certain to be further reduced, as experience accumulates in the manufacture and the design becomes simplified.

Another reason why Americans have hesitated to take up the Diesel engine has been the high-class of workmanship necessary. There are certain lines of American machinery industry in which the standards of accuracy and workmanship are as high as obtain in any country of the world. There are other lines, however, in which too many American shops are pursuing the haphazard cut-and-try methods which were everywhere common a generation ago. It is true that not every country machine shop could embark on the manufacture of Diesel engines and make a success. To put the matter still more strongly, there are probably few American engine builders which are at present able to provide the high grade of design and workmanship necessary for successful Diesel engine construction.

This, however, cannot possibly be a permanent condition. The advantages of this type of prime mover have been recognized and taken advantage of by the mechanical engineers of every other industrial country in the world. Now that these advantages are abundantly demonstrated, the fact that high-class workmanship and intelligent attendance are required should no longer be sufficient bugbears to prevent the extensive use of this engine in the United States.

It should be clearly understood, also, that the term Diesel engine today designates not a machine but a type. There is a great variety in the designs produced by the engine builders of various countries. And while the type is a long step forward in engineering, the perfection of the type is still far from accomplishment. Inventors and designers of all the industrial nations of Europe are eagerly striving to excel each other in the improvement of the type, and progress is very rapid. It is to be hoped for the credit of American mechanical engineering that engineers in this country also may not be content to merely copy the product of foreign manufacturers, but may contribute something toward progress in this important field.

Annual Meeting of the American Society for Testing Materials

With distinctly more active and voluminous discussion of specifications than at any previous meeting, the abbreviated annual meeting of the American Society for Testing Materials, at New York City, last week (Mar. 28-29, 1912), was successful in unexpected degree. It will be remembered that the usual plan of a midsummer week's meeting at Atlantic City was changed this year, in order to concentrate interest on the congress of the International Association for Testing Materials, to be held in New York City in September. The meeting was restricted to specifications, and was convened three months earlier than usual.

The activity of this meeting may be due to separating specification work from the presentation of independent papers, or it may be due to the new system of committee organization introduced last year. Each committee now splits up its work into as many self-contained problems or phases as possible, and assigns these to subcommittees, who are expected to report comprehensively and completely to the central committee. The practical effect, as shown by the year's results, is that the society's work is done by a larger number of separate committees than before. How much centralization each main committee can bring about is yet an open question.

The outcome of the specification work is recounted below. Concerning the other business of the meeting, it need only be said that new officers were elected, and that the bylaws were amended (1) to secure rotation of office and (2) to create the grade of Honorary Member, a grade having no dues to pay and limited to a maximum of 10 incumbents at any one time.

Presidential Address

President H. M. Howe addressed the meeting in a scholarly forecast of the future possibilities of the society's work. He emphasized particularly the new paths which are opening in the direction of securing international specifications for some of the principal materials. He referred approvingly to the slight but important changes which are coming about in the society's management by bringing in new blood into the management, and by securing more active coöperation of the Federal Government (signalized at this time by the election of Mr. S. W. Stratton, Director of the Bureau of Standards, to the Executive Committee). A rather forceful plea for active consideration of the rail question was also embodied in his address, and this part we have extracted and present at the end of this report. However (not unexpectedly), the steel committee reported that it did not recommend action on the society's rail specifications this year.

New Officers

The new officers elected are: President, Robert W. Hunt, of Chicago, Ill.; Vice-President, A. W. Gibbs, of Altoona, Penn.; Secretary and Treasurer, Prof. Edgar Marburg, University of Pennsylvania, Philadelphia; Members of the Executive Committee, J. B. Lober, and A. A. Stevenson, of Philadelphia, Penn., and S. W. Stratton, of Washington, D. C.

Control of Style of Specifications

An important innovation was the formulation during the past year, by a special committee appointed for the purpose, of "rules governing the form but not the substance of specifications." The report was presented at the meeting in printed form, and though no opportunity was offered for consideration of its contents, it was accepted and hereafter will be binding on the technical committees. The special committee which drew the rules will be continued and will exercise editorial functions in connection with all specifications which may hereafter be adopted by the society. The records of the society show a fertile field of work for this committee.

A related matter was brought up by Mr. H. S. Spackman (Philadelphia, Penn.). He said that specifications often come before law-courts, and that they should be good enough to pass muster in court; that the society's cement specification has been all picked to pieces in court as contradictory, and that such unfortunate conditions could be avoided by submitting the specifications to "counsel" before adoption. At the secretary's suggestion, this matter was referred to the Executive Committee for consideration.

In the following summary of the action taken on new specifications, it is to be remembered that letter-ballot vote of the entire membership of the society is taken on the adoption of any specification, after acceptance by the meeting. Our statements of favorable action by the meeting therefore imply reference to letter ballot. The action of the meeting, however, is final in making amendments to a proposed specification.

Specifications

Magnetic Testing—A slight change was recommended by the committee on the magnetic testing of iron and steel (chairman, C. W. Burrows, Bureau of Standards, Washington, D. C.), placing the compensating coils over the ends of the main coils in the square arrangement of test bars. The change was accepted by the meeting.

Soft and Medium-hard Copper Wire—Specifications for hard-drawn copper wire having been previously adopted, Committee B-1 (chairman, J. A. Capp, Chief of Testing Laboratory, General Electric Co., Schenectady, N. Y.), presented at this meeting specifications for soft copper wire and for medium-hard copper wire, this latter quality being soft wire rendered somewhat hard by drawing down to a slightly smaller size. The specifications recommend the use of resistivity value of 0.15302 and a specific gravity value of 8.90. These two values have been customary in American practice, agree with the qualities of commercial material, and are the same as used in the previously adopted specifications for hard-drawn copper wire and for copper-wire bars. On the other hand, they differ slightly from the values which are before the International Electrotechnical Commission for adoption. This fact led to protest by Mr. C. W. Burrows (Bureau of Standards, Washington, D. C.), and Mr. C. O. Mailloux (American Institute of Electrical Engineers); the latter particularly pressed the harmony argument. After reply by Mr. Capp, a conference of the parties was directed, and this led later in the meeting to a vote accepting the specification with the understanding that the numerical value of resistivity will be subject to modification when an agreement has been reached by the Electrotechnical Commission. It is likely that the committee will urge consideration of the American values to the Electrotechnical Commission.

Coke—A very interesting statement was made by Committee D-6, on Standard Specifications for Coke (chairman, C. H. Zehnder, New York City). The committee has concluded that it is *not feasible*, in the present state of the art, to formulate standard specifications for beehive and byproduct coke. As an initial step, it will be necessary to decide on standard methods of sampling and testing, and work on this problem has been started through a subcommittee; in matters of chemical analysis, the committee will work in coöperation with the American Chemical Society and the American Foundrymen's Association. The committee has also begun to collect data on physical testing of coke.

Wrought Iron

Mr. S. V. Hunnings (Engineer of Tests, American Locomotive Co., Schenectady, N. Y.), chairman of Committee A-2, on Specifications for Wrought Iron, submitted four specifications, one of these being a revision while three are new: Stay-bolt iron; engine-bolt iron; refined wrought-iron bars; and iron locomotive-boiler tubes. During the coming year it is expected that specifications for the following wrought-iron products will be studied: Chain iron; rivet iron; hammered-iron sections; and plates and rolled shapes.

The four specifications submitted contain clauses prescribing an etch test to differentiate wrought iron from steel:

> The cross-section of the test specimen shall be ground or polished, and etched in a solution composed of 50% water, 25% concentrated sulphuric acid and 25% concentrated hydrochloric acid, for a sufficient period to develop the structure. This test shall show the material to be free from steel.

A fuller explanation of the test is given only in the boiler-tube specifications, though in this the test is not prescribed but permissive ("in case of doubt as to the quality of material"). It adds to the above directions the following:

> The chemical action shall be allowed to continue until the soft parts are sufficiently dissolved for the iron tube to show a decided ridged surface, with the weld very distinct, while a steel tube would show a homogeneous surface.

Presumably the ridged structure should also be obtained with bars and bolts.

The strength and ductility values required for the four kinds of iron are:

	Ultimate strength	Yield point / ultimate	Min. elongation % in 8 in.	Min. reduction of area, %
Staybolt iron†	49–53,000	0.6	30	48
Engine-bolt iron	50–54,000	0.6	25	40
Refined bars	*48,000	25,000	22	
Boiler tubes	Quench bend; nicked bend; hydraulic test 500–750 lb.; drifting test; no tensile or vibration test.			

*Twenty per cent. of the test specimens may vary from 47,000 to 53,000; none may be below 45,000. †Vibration test also specified, but eliminated for the present to permit standardizing the test method.

The four specifications were passed to letter-ballot vote of the society at large, after having been amended in various minor respects on motion of the committee, whose last session was held after the specifications had been printed.

The vibration test for stay-bolts appears to give erratic results, and while it appeared in the printed draft of the specification the committee finally eliminated it for the present, pending further study.

Steel

Steel products specifications were easily the principal part of the meeting's program. But T-rails, which are, in some respects, the most interesting in the list of steel products, were not touched; the chairman of Committee A-1, Mr. W. R. Webster (Philadelphia, Penn.), explained that T-rails were left unconsidered because of a desire to have all possible definite information in hand before making any decisive changes in the existing rail specifications. Studies are being made by the American Railway Engineering Association, and the Interstate Commerce Commission, and some other bodies are also at work in the field. Committee A-1 hopes for the coöperation of all these bodies in considering rail specifications during the coming year.

The work of Committee A-1 has been very thoroughly specialized by splitting it up among 13 subcommittees, each charged with specifications for certain groups, embracing from one to five kinds of material. At least 25 to 30 specifications will ultimately be produced by the subcommittees. At the present meeting, four revisions and eleven new specifications were submitted, and some of them stirred up rather brisk discussion.

However, these steel specifications should rather be regarded as a set of half a dozen independent committee reports, inasmuch as the subcommittees reported for themselves, and in case of attack the burden of defense was not usually assumed by the central committee.

Rail Splice Bars—The existing specification was amended by the committee to make the tensile-strength range 55,000-65,000 (in place of 54,000-64,000). This has the object of uniformity. The change was accepted.

Steel Reinforcing Bars—The specification adopted last year required bars for concrete reinforcement to be rolled *from billets*. The committee now proposed to emphasize this by making it read "from *new* billets," and by adding the unequivocal statement *"No rerolled material will be accepted."* Therefore the Rail Steel Bar Manufacturers Association sent a strong delegation to the society's meeting, which, after stating that it represented 200,000 tons annual output, made loud complaint against the proposed clause, and said that the association had not obtained a hearing before the committee. Sharp discussion followed; it was marked by the fact that no one (except perhaps Mr. Webster) argued that rerolled-rail bars ought not to be used as reinforcement. In substance, no defense was made, except the statement that the proposed clause merely made more clear the same meaning that was intended to reside in the old specification. The obvious correctness of this explanation, however, furnishes no reason why, in a specification entitled broadly "Steel Reinforcing Bars," the committee inserted the billet provision at all, in view of the fact that only Mr. Webster even implied a support of the rerolled prohibition.

In the middle of the wordy battle, Mr. R. L. Humphrey (Philadelphia, Penn.), a member of the Reinforced Concrete Committee, attempted a clever flanking movement by demanding that the subject of specifications for reinforcing bars be taken from the Steel committee and entrusted to the Reinforced-Concrete committee; he could not carry his claim, however. At the same time it appeared that the proposed clauses could not secure the approval of the meeting, and inasmuch as the meeting was powerless to abrogate the existing specifications, it looked like a deadlock. Prof. Edgar Marburg (University of Pennsylvania, Philadelphia, Penn.), secretary of the Steel committee, at this juncture came out with a novel suggestion. He said that the specification should not be regarded as covering all reinforcing bars, but only those which it admitted; materials barred out by this specification might (and ultimately should) be admitted by additional specifications, not yet prepared.

He thereupon moved that the amendatory clause proposed by the committee be accepted with the distinct understanding that the whole specification is not to be construed to be in prejudice to any material not covered by the specification. The question whether this reservation applies to bars which fail to meet the strength or ductility requirements set by the specification was not entered upon. However, the motion was carried, which ended the controversy.

Structural Nickel-Steel—Mr. H. W. Hodge (New York, N. Y.) presented the new specifications for structural nickel-steel, based on his specifications for the St. Louis Municipal Bridge. On motion of Mr. J. O. Leech (Carnegie Steel Co., Pittsburg, Penn.), a slight change was made by varying the elongation inversely as the tensile strength, instead of fixing it at 16%. But another suggestion by him to weaken the bend test for thick bars (by making the diameter of the mandrel three times the thickness of the plate instead of twice, for plates thicker than ¾ in.), was opposed by Mr. Hodge, on the ground that better results are obtained commercially without trouble, and was lost.

The specification was accepted by the meeting.

Automobile Carbon and Alloy Steels—As reported by Mr. A. L. Colby (South Bethlehem, Penn.), this specification was developed from those recently presented to the Society of Automobile Engineers, and uses the same lists of chemical composition.

The notable feature is that *no tests* or requirements are specified, though methods applicable in case such tests should be wanted are described. The specification gives lists of chemical compositions for a range of carbon grades of:

- Carbon steel
- Nickel-steel
- Nickel-chromium-steel
- Nickel-vanadium-steel
- Nickel-chromium-vanadium-steel
- Chromium-steel
- Chromium-vanadium-steel
- Silicomanganese-steel
- Valve metal,

and fixes methods of sampling and procedure of inspection. The specification was accepted by the meeting.

Openhearth Girder Rails—Two grades of girder and high T-rails of

openhearth steel were covered by a new specification; one grade has 0.60 to 0.75% carbon, the other 0.70 to 0.85%, with a lower drop test required for the latter. The drop test is not very severe, but in explanation it was said that during the last year some 90% of all rails of this kind were not tested under the drop.

The specification was accepted by the meeting.

STEEL WHEELS—Forged, rolled, or forged and rolled wheels were covered by two specifications, one for freight-car wheels, and the other for all other wheels. Objection promptly developed against including wheels for motor railway service in the last mentioned specification. This was on the part of Interborough Rapid Transit representatives, and the committee heeded the protest by eliminating reference to motor railway service.

Further objection was made because the specification as drawn did not meet fully the possible M.C.B. gaging (necessary for interchange reasons), and because proper conference with M.C.B. representatives had not been had. It was urged also that the title should limit the specifications to openhearth wheels, so as not to prejudice the use of crucible- or alloy-steel wheels. These objections were met by making the title contain "solid *carbon* steel wheels," and by promise of full conference during the coming year with readiness to make any necessary revision to suit the Master Car Builders' needs. On the explanation that several very large railways are using many wheels bought practically under the proposed specification, the meeting accepted the specification as changed, without dissent.

LOCOMOTIVE MATERIALS—Specifications for boiler and firebox steel, boiler rivets, forgings, boiler tubes, and shapes and plates, were submitted by F. J. Cole (American Locomotive Co., Schenectady, N. Y.) for the subcommittee on Locomotive Materials. These were all accepted, after slight final modifications by the committee, and a few other changes.

For rivets, there was discussion on the sulphur limit; J. O. Leech (Carnegie Steel Co., Pittsburg, Penn.) demanded 0.045% in place of 0.04%. It was reported that large quantities of locomotive-boiler rivets have been bought well below the 0.04% limit, but the meeting finally accepted the 0.045% figure. It was further voted to require no tensile test of rivets if a test of the rivet bar can be furnished. As the number of samples for testing, three rivets from each "lot" was fixed, by vote of the meeting.

The specifications for lapwelded boiler tubes was broadened to cover also seamless tubes. For lapwelded tubes, a fixed variation of thickness is allowed (0.01 in., and 0.015 in. at the weld), but for seamless tubes the meeting voted to add a clause allowing 10% variation from the thickness specified, thus making the variation depend on the thickness.

HEAT-TREATED AXLES AND SHAFTS—This specification led to a revival of the acid vs. basic-steel controversy, by a proposal to fix a lower phosphorus limit (0.04%) for basic steel, the specified 0.05% being selected to suit axles made of acid steel. The meeting voted, however, to retain the single figure 0.05%.

Then arose much discussion about phraseology, in the question of specifying one test for each lot of pieces that are both quenched and annealed together. A suitable, though complex, phrasing was finally secured, and the specification was then accepted by the meeting.

The point at issue was of general interest in showing how these technical specifications are frequently drawn in such a manner that a slight change in customary procedure will render their proper meaning quite unclear. The Style Committee is expected to help toward improvement in this respect. However, in the specification mentioned next, this committee created a dispute rather than prevented one.

STEEL CASTINGS—This existing specification was revised during the past year by several minor changes, among them one which eliminates the annealing for those castings which do not have to meet fixed physical requirements, and at the same time sets a lower carbon limit (0.30%) for such castings. Also, test pieces are not to be cut from sinkheads as now, but from coupons attached to the castings.

In the clause on bend tests, it was specified that "Bend tests *may* be made by pressure or by blows," the Style Committee having added this clause. The committee proposed to add, "at the option of the manufacturer," in order to define the meaning. Railway representatives, however, protested against this addition, and declared broadly that the purchaser should never be limited in the method of making his tests. After various voting and reconsidering, the meeting decided that "purchaser" should be substituted for "manufacturer."

Since many other specifications of the society have a similar permissive clause, it was then proposed to add the purchaser's option to all these clauses. The motion was withdrawn after some discussion, but the result is to create a presumption, at least, that each such permissive clause will really require the material to be such that it will stand both a pressure bend and a hammer bend.

Hereupon the entire clause "Bend tests may be made by pressure or by blows" was taken out of the Steel Castings specification, and in this form the specification was accepted by the meeting. The clause remains in other specifications.

COLD-ROLLED AXLES — A specification was presented, but the committee requested that no action be taken on it at this meeting, so as to leave it open for consideration during the coming year.

OTHER SUBJECTS

A number of technical committees reported progress in general terms or with a brief statement concerning the studies which they are undertaking. These were: Committee B2, on Nonferrous Metals and Alloys (chairman, Prof. Wm. Campbell, Columbia University, New York City); Committee C4, on Standard Specifications and Tests for Clay and Cement Sewer Pipes (chairman, Rudolph Hering, New York City); Committee C6, on Standard Specifications and Tests for Drain Tile (chairman, Prof. A. Marston, Iowa State College, Ames, Iowa); Committee D8, on Waterproofing Materials (chairman, W. A. Aiken, Philadelphia, Penn.); Committee E3, on Definition of the Term Modulus of Elasticity (chairman, Leonard Waldo, New York City); and Committee C1, on Standard Specifications for Cement (chairman, Prof. George F. Swain, Harvard University, Cambridge, Mass.).

CEMENT—The report of the cement committee was a shortened repetition of the cement report made at the meeting of the American Society of Civil Engineers in January, 1912. It stated that a board had been established by several governmental departments to draw up a cement specification for U. S. Government use, that meetings were held with that board in the endeavor to reach identical specifications, and that substantial agreement had been secured. The points of difference are the test for normal consistency (where the Department Board prefers the ball test) and the test for set (where the Board uses the Gillmore needles instead of the Vicat needle).

WATERPROOFING—The report of the waterproofing committee brought about some excited discussion, during which several persons affirmed their belief in the imperishability of concrete and protested against sanctioning any hint of any other possibility. The final outcome was that the progress report was sent back to the committee for revision. An interesting feature of the discussion was the statement that the committee is made up virtually of two groups: The impermeability men and the extraneous-waterproofing men; the implication was that the committee has a sort of cat-and-dog time in reaching any conclusions. Another item of interest was the statement by C. de Wyrall (Interborough Rapid Transit Co., New York City) that he has seen a thick concrete wall, originally made in best manner of 1:3:5 mixture, disintegrated to the degree that it was soft and rotten for a foot of thickness, over an area of many square feet, so that serious collapse would have occurred except for the fact that the wall carried no load. Mr. de Wyrall, who is a member of the committee, placed himself in the im-

permeability group, by the statement that his 9 years' experience indicates that extraneous waterproofing materials are very good materials provided water is kept away from them.

DEFINITIONS OF BITUMINOUS TERMS—L. W. Page (Office of Public Roads, Washington, D. C.,) as chairman submitted a committee report in which definitions were proposed for various terms used in connection with bituminous substances. The report was accepted by the meeting.

ELASTIC LIMIT OF STRUCTURAL STEEL—A. W. Carpenter (New York Central & Hudson River R.R., New York, N. Y.) called attention to the fact that the society's present specification for bridge steel does not make any elastic requirement. He characterized this as a serious omission from the bridge engineer's standpoint, and gave notice that he would bring the matter to the attention of the steel committee.

Rail Failures and Specifications: The Duty of a Technical Society*

BY HENRY M. HOWE†

We should inquire carefully whether we are in part responsible for the needless killing and maiming of our fellow citizens on our great national highways, the railroads. I am not in a position to know the merits of the case, or to say whether culpability actually exists anywhere, much less to apportion it. But if what is said on apparently good authority is even approximately true, then the reason to believe that there are very many preventable deaths and injuries on our railroads is so strong as to demand investigation on the part of all even remotely responsible, and to demand that those situated as we are should ask carefully whether we, too, are not in part responsible.

For a preventable death, for a death which I can prevent but do not, I am accountable. In that I do not prevent it I permit it; my omission to prevent, my effective permission, determines the death.

We set up standards for rails. It is strongly suspected and at times asserted that the breakage of these rails causes many needless deaths. If those rails are bought under our specifications, and if those specifications do not fully secure the very least attainable danger of breakage, we, as the experts on whose judgment these rails have been permitted, through their breakage, to kill our fellow men, are in a measure responsible. If the rails which imperil the lives of our fellows are bought not under our specifications but under looser and improper ones, then certain questions loom up. Are we, because of our expert knowledge of the manufacture, testing, and uses of rails, in a position to inform ourselves as to whether such specifications fail to protect our fellows thoroughly, and thus actually doom some of them to death? Such insufficient specifications are pistol shots fired indeed into a crowd and aimed at no individual, but none the less carrying death, and carrying it with the knowledge and the permission of those who could prevent it if they would.

If preventable practices are now continuing which are going to kill many men, practices the dangerous nature of which we are in a position to recognize and convincingly to expose; if, under these conditions we omit to exert our power of detection and exposure, shall we not be in a measure responsible for those future deaths, as I am responsible in part for the death of a drowning man to whom I fail to throw the life belt in my hand? Is it not our duty to do overtly what lies in our power to save the lives and protect the bodies of our fellows?

To determine what acts would be most effective would require very careful consideration, and a knowledge which I manifestly lack. An offer, a tactfully insistent offer of our aid to the bodies whose legal duty it is to investigate and remove the supposed dangers, is a possible one, perhaps more promising than an independent investigation on our own part.

It is idle to plead that the fault lies primarily elsewhere; that the railroads are in part to blame, and the traveling public in part, because of its inconsiderate demands for unsafe speed. My duty toward the drowning man is unaffected by his having come into the water through his own fault or that of another; it is unlessened by the apathy of the police and of the other onlookers. My duty is my duty. It depends solely on my own condition and powers, and not on the faults of others.

The question then seems to resolve itself into these: First, is there a considerable number of rail breakages capable of prevention by means of better specifications? Second, can we contribute directly or indirectly toward bettering those specifications by directing attention to their present defects? I commend these questions to your thoughtful consideration.

* A passage in the Presidential Address to the American Society for Testing Materials at its annual meeting, New York City, Mar. 28, 1912.

†Bedford Hills, N. Y.

Triple-Truck Passenger Cars are being used for suburban trains on the Great Northern Ry. (England). Each car consists of a pair of car bodies put together, with one truck under the connection and one at each end. The cars are 80 and 90 ft. long, with trucks spaced 36 ft. between centers. The truck wheelbase is 8 ft.

The Flood of March 22, at Pittsburg, Penn.

BY KENNETH C. GRANT*

On Mar. 22, 1912, the Allegheny and Monongahela Rivers, which join at Pittsburg to form the Ohio, reached a gage height of 28.1 ft., the highest stage since Feb. 16, 1908, when there was a 30.7-ft. flood. Except for a second flood in 1908, on Mar. 20, which reached a stage of 27.3 ft., no other flood of importance had occurred at Pittsburg for four years, although the danger line of 22 ft. had been reached several times, the highest stage occurring on Jan. 31, 1911, when the rivers rose to a gage height of 25.2 ft. The record stage of 35.5 ft. occurred on Mar. 15, 1907, when about $6,000,000 of flood damage resulted.

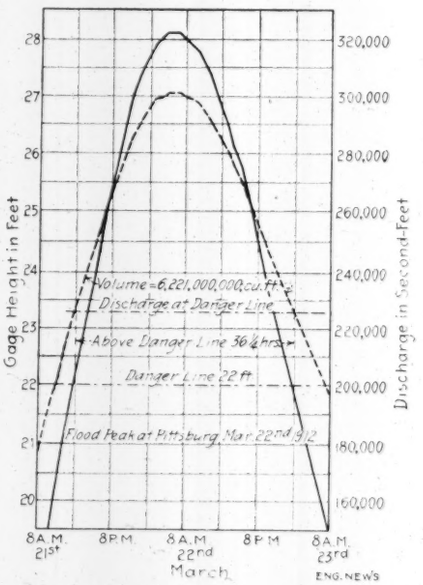

FIG. 1. GAGE HEIGHTS AND VOLUME DISCHARGES AT PITTSBURG, MARCH, 1912

(Gage heights shown in dash lines; discharge in solid lines.)

In view of the exhaustive studies looking toward methods of flood relief that have been made by the Flood Commission of Pittsburg, which is shortly to publish its report, it is thought that a brief description of the recent flood will prove of interest at this time.

The gage at Pittsburg registered 17.9 ft. at 8 a.m. on the 21st. For five days prior to this date the rivers had been flowing fairly full, the gage readings at Pittsburg varying between 13 and 18 ft. The weather had been mild, and the high temperatures that prevailed for part of the time had gradually brought the ice out of the tributaries and headwaters of the Allegheny during this period. The ice on the Monongahela and its tributaries had already gone out some time before. Had cold weather continued until the 20th,

*Principal Assistant Engineer, Flood Commission of Pittsburg, Arnott Bldg., Pittsburg, Penn.

TABLE I. DAILY GAGE HEIGHTS AT RIVER STATIONS. FLOOD OF MAR. 22, 1912

Stream	Station	March 15	16	17	18	19	20	21	22	23	24	25	Highest Recorded Stage: Stage	Date
Allegheny R.	Warren	F 1 8	F 3 0	5 5	7 0	7 7	8 9	9 7	7 7	6 0			17 4	Mar. 1865
Tionesta Cr.	Nebraska	3 7	5 5	3 4	1 4	4 5	1 7	4 0	3 6					
Oil Cr.	Rouseville	2 3	3 3	3 6	4 0	3 8	4 5	3 6						
French Cr.	Carlton	5 5	8 2	6 9	7 8	9 2	10 5	a 10 6					16 5	1888
Allegheny R.	Franklin	F 2 3	F 4 7	5 9	9 1	9 8	11 6	11 6	9 9	7 9				Mar. 17, 1865
Clarion R.	Clarion	F 2 7	b 13 0	4 6	6 0	4 3	6 0	6 6	5 6	5 0			16 0	Mar. 20, 1905
Allegheny R.	Parker	F 2 7	F 5 5	7 6	10 4	10 7	11 9	12 7	11 4	8 1			28 0	Mar. 1865
Allegheny R.	Kittanning		9 5	16 4	13 7	14 1	15 5	c 17 2	14 9				29 3	Mar. 1865
Red Bank Cr.	St. Charles	7 2	6 2	5 9	5 5	5 7	5 8	6 2	5 7					
Black Lick Cr.	Black Lick	7 2	6 9	5 4	5 5	5 4	5 6	d 10 1	8 0				13 2	Mar. 14, 1907
Conemaugh R.	Johnstown	6 7	7 0	4 5	5 9	5 9	7 3	e 11 8	10 0	6 3			21 0	May 31, 1889
Kiskiminetas R.	Saltsburg	3 1	8 5	4 5	4 3	4 3	4 3	f 8 5	12 0	5 8			22 1	1859
Kiskiminetas R.	Avonmore	11 7	15 6	10 8	10 6	10 4	11 7	g 22 8	22 0				33 9	1859
Allegheny R.	Freeport	8 0	14 0	11 4	12 3	14 7	15 5	h 19 3	22 2	15 5			32 7	Feb. 18, 1891
Monongahela R.	Fairmont	19 2	23 6	22 0	17 6	16 6	16 6	k 19 3	20 6	19 0			37 0	July 10, 1888
Cheat R.	Rowlesburg	5 6	9 0	5 6	1 0	3 7	4 4	l 6 0	6 7	5 2			22 0	July 10, 1888
Monongahela R.	Greensboro	12 8	20 9	15 3	11 8	10 3	10 5	m 16 3	18 3	13 9			39 0	July 10, 1888
Monongahela R.	Lock No. 4	17 5	25 7	23 2	17 0	13 3	12 7	n 18 3	27 5	20 5			42 0	July 11, 1888
Youghiogheny R.	Confluence	4 4	8 3	5 0	4 4	4 3	5 4	p 9 8	10 3	6 0			18 6	Mar. 14, 1907
Youghiogheny R.	Connellsville	8 2	10 9	7 0	6 6	6 1	7 6	r 14 7	12 3					Mar. 14, 1907
Youghiogheny R.	W. Newton	4 9	11 1	8 3	6 0	5 3	5 8	s 11 8	19 8	9 9			28 2	Mar. 14, 1907
Ohio R.	Pittsburg	9 6	18 3	17 9	13 1	13 4	13 3	17 9	t 28 0	19 6			35 5	Mar. 15, 1907
Ohio R.	Wheeling	12 8	19 7	27 0	25 5	21 4	21 0	21 9	33 3	u 38 4	31 4	25 5	53 1	Feb. 7, 1884
Ohio R.	Parkersburg	15 7	23 4	26 2	28 0	26 0	23 6	24 0	29 0	34 8	v 36 5	35 8	53 9	Feb. 9, 1884
Ohio R.	Cincinnati	37 2	42 6	44 0	45 4	46 6	47 0	46 5	47 0	45 2	45 8	w 50 2	71 1	Feb. 11, 1884

F. Frozen. a. Max. at noon, 10.7. b. Ice gorge; broke 5 a.m. on 17th. c. Max. at 4 p.m., 1.72. d. Max. at 1.00 p.m., 11.1. e. Max. at noon, 13.6. f. 14.0 at 2 p.m.; still rising. g. Max. at 8 p.m., 28.0. h. 23.2 at 6 p.m.; rising 0.1 foot per hour. k. Max. at 6 p.m., 21.4. l. Max. at 2 p.m., 7.0. m. Max. at 4 p.m., 20.0. n. 26.2 at 8 p.m., rising 0.5 foot per hour. p. No record of maximum.; must have occurred in afternoon. r. Max. at 3.30 p.m., 17.35. s. Max. at 8.00 p.m., 22.7. t. Max. 5.00 to 7.00 a.m., 28.1. u. Max. about 3 a.m., 38.6. v. Max. at 4 p.m., 37.0. w. Mar. 26, 8 a.m., 52.2.; Mar. 27, 8 a.m., 53.2 and rising; max. probably about 53.3 at noon.

when the flood rainfall began, the ice on the Allegheny would have been held back until then and the flood would have been considerably higher and might have been dangerously increased by ice gorges. The ice moved out of the upper Allegheny and its tributaries on the 17th. On the Clarion River a heavy gorge formed below Clarion, raising the stage at Clarion on the 16th to 13 ft., which rapidly reduced to 4.6 ft. on the 17th, when the ice moved out early in the morning. Ice was running on the Allegheny at Parker on the 16th and 17th and began passing Freeport on the morning of the 17th.

During the 21st the rivers at Pittsburg rose rapidly and crossed the danger line, or 22-ft. stage, about 2 p.m., rising steadily until 5 a.m. on the 22d, when the maximum of 28.1 ft. was reached (Fig. 1). The crest remained at this level for two hours, and then dropped at about the same rate as it had risen, falling below the danger line at about 2 a.m. on the 23d, and registering 19.6 ft. at 8 a.m. The rise was probably checked to some extent by a sudden drop in temperature on the 21st. The water was above the danger line for about 36 hours, during which time the total discharge above the 22-ft. stage was about 6,221,000,000 cu.ft. The discharge at the crest of 28.1 ft. was about 300,000 sec.-ft.

The rainfall causing this flood practically all fell in the 12 to 14 hours preceding 8 a.m. on the 21st. After the middle of March, with the exception of an inch or two in the extreme northern Allegheny Basin, there was no snow on the ground to contribute to the flood run-off. The precipitation recorded at 8 a.m. on the 22d occurred in the few hours following 8 a.m. on the 21st. Unfortunately, only meager records are available at this writing, as the U. S. Weather Bureau rainfall stations, except those at river stations, do not report their readings until the end of the month. The records on hand at this time, however, are sufficient to indicate the general distribution and amount of the rainfall, except in the extreme southern portion of the Monongahela Basin.

TABLE II. RAINFALL ON ALLEGHENY AND MONONGAHELA BASINS PRECEDING FLOOD OF MAR. 22, 1912, AT PITTSBURG

Station	March 20	21	22	Remarks
Clarion, Pa.	0.00	0.90	0.12	
Confluence, Pa.	0.62	2.01	0.33	
Davis Is. dam, Pa.	0.16	0.87	0.06	On Ohio river, about 5 miles below Pittsburg
Fairmont, W. Va.	0.52	1.21	0.38	
Franklin, Pa.	0.05	1.02	0.05	
Freeport, Pa.	0.03	1.50	0.11	
Greensboro, Pa.	0.70	1.30	0.24	
Herr Is. dam, Pa.	0.20	1.12	0.05	On Allegheny River, about 1.5 miles above Pittsburg
Johnstown, Pa.	0.44	2.65	0.26	This is maximum during storm
Lock No. 4, Pa.	0.42	1.17	0.02	
Parker, Pa.	0.00	0.71	0.05	
Pittsburg, Pa.	0.22	1.07	0.01	
Bowlesburg, W. Va.	0.78		0.70	No report for Mar. 21
Saltsburg, Pa.	0.18	1.52	0.11	
Warren, Pa.	0.20	0.60	0.06	
W. Newton, Pa.	0.40	2.10	0.09	

The precipitation was lightest over the northern Allegheny Basin, where it was mostly in the form of snow. The upper Allegheny, therefore, contributed little to the rise, especially as practically all of the 6 in. of snow that fell was still on the ground on the 23d. French Creek was at fairly high stage, being above 10 ft. throughout all of the 20th and 21st. The Clarion, however, rose to only 6.6 ft., 9.4 ft. below record stage, and Red Bank, Mahoning and Crooked Creeks were not important contributors; so that the Allegheny at Kittanning rose to only 17.2 ft., 12 ft. below record stage, at 4 p.m. on the 21st. At Freeport the river registered 23.2 ft. at 6 p.m. on the 21st, when the water was rising 0.1 ft. per hour. The main contributor from the Allegheny Basin was the Kiskiminetas River, which reached a stage of 28 ft. at Avonmore at 8 p.m. on the 21st, nine hours before the crest was reached at Pittsburg.

On the Monongahela Basin, the Cheat, Tygart Valley and West Fork Rivers were not important factors in the rise. The Youghiogheny, however, was an important contributor and, with the Kiskiminetas, was the main cause of the high stage reached at Pittsburg. It reached a stage of 22.7 ft. at West Newton at 8 p.m. on the 21st. Except during the flood of March, 1907, when the maximum at West Newton was 28.2 ft., this river had never been higher than 22 ft. at this station. The time necessary for floods of these heights to move from West Newton and from Avonmore to Pittsburg is from 9 to 12 hours, and both the Youghiogheny and Kiskiminetas must, therefore, have delivered their greatest discharge at Pittsburg at about flood peak time, between 5 and 7 a.m. on the 22d.

The gage heights and the rainfall at various points along the drainage area are shown in Tables I-II, and the stages of the flood at Pittsburg in Fig. 1.

The high stage in the Kiskiminetas and Youghiogheny Rivers was to be expected, as the rainfall was heaviest over their basins. The maximum rainfall recorded during this storm, insofar as shown by the limited records now available, was at Johnstown, Penn., on the Kiskiminetas Basin, where 2.65 in. fell in the 12 to 14 hours preceding 8 a.m. on the 21st. The rain continued for a short time after 8 a.m. on this day, an additional precipitation of 0.26 in. being recorded. The next greatest rainfall was at Confluence, Penn., where 2.04 in. fell during the same period, and 0.33 in. immediately afterward. It is probable that when complete records are at hand, they will show a heavier rainfall than the above amounts at points higher up on these two basins. A line forming the western boundary of the region that received 2 in. or more of rainfall would pass a short distance to the

east of Parsons and Rowlesburg, W. Va., and Uniontown and Lock No. 4, Penn., and turn northwestward about through Greensburg and Blairsville, Penn. West of this line the entire drainage area received between 1 and 2 in. as far north as Clarion, Penn., and from here the precipitation decreased northwardly, in the extreme northern portions of the Allegheny Basin being, as stated above, largely in the form of snow, but little of which melted and ran off with the flood. The generally light rainfall recorded at 8 a.m. on the 20th fell mostly between 8 p.m. on the 19th and 1 a.m. on the 20th, and had but slight influence upon the Pittsburg peak.

Damage by Flood

The damage caused by this flood at Pittsburg and other communities bordering the rivers above and below the city was considerable. A careful census of flood damage, made by the Pittsburg Flood Commission after the 27.3-ft. flood of Mar. 20, 1908, showed a direct loss at Pittsburg alone, for a flood about a foot lower than the recent stage, of over $400,000. It would seem reasonable, therefore, to place the direct loss in the recent flood at about $500,000, although when complete information is at hand, this figure may be modified, especially as certain streets in the flooded district were raised during 1911. About 250 acres of the low-lying portions of the city, including perhaps 40 acres of railroad and industrial yards, were submerged to a maximum depth of about 9 ft. Several miles of main-line railroad and of street-car tracks were submerged, the water reaching a depth of about 8 ft. on the B. & O. tracks along the right bank of the Allegheny (Fig. 2). Approximately 6 miles of streets and alleys were submerged to a greatest depth of about 7 ft.

The night of the 21st was one of discomfort to thousands of people living in the low-lying portions of the city. Most of the residents of these districts moved their furniture upstairs and remained in their houses. Others left their homes in boats manned by the police. Dozens of small boats plied the streets of lower Allegheny carrying people to and from their homes. Damage and discomfort of a similar nature were experienced in all the low-lying towns along the rivers above and below Pittsburg.

The interference with business was not serious. The downtown business section was not invaded as in the great flood of 1907, although cellars were flooded by seepage and backwater from the sewers, and pumps had to be operated while the rivers were at flood stage. Merchandise and other materials stored in cellars and basements had to be removed to the sidewalks or to higher portions of the buildings. The merchants in the lower districts, as a precaution, had stop-plank flood gates in place on the night of the 21st. The accurate prediction of 28 ft. made by the Local Forecaster of the U. S. Weather Bureau gave ample time to prepare for the flood and much valuable property was saved thereby.

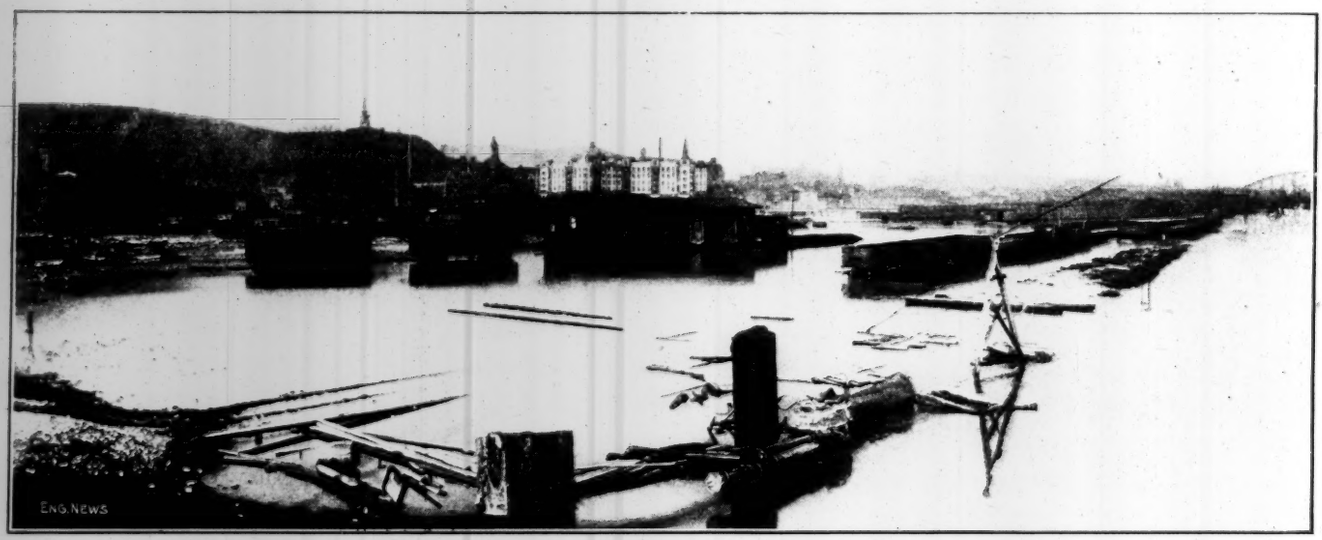

Fig. 2. Part of B. & O. R.R. Yards on North Side; from Right Abutment of New Union Bridge

Movement of Flood down Ohio River

The flood crest reached Rochester, Penn., 25 miles down the Ohio from Pittsburg, at about 11 a.m. on the 22d. The streets and cellars in the lower section were flooded. At Steubenville, Ohio, 68 miles below Pittsburg, 37 ft., the highest stage, was reached on the evening of the 22d. Several industrial plants were shut down and railroad and street-car traffic was interrupted. At Wheeling, W. Va., 90 miles below Pittsburg, the water rose above the danger line of 36 ft. at 1 p.m. on the 22d and reached the maximum for this flood, 38.6 ft., at about 3 a.m. on the 23d. Street-car traffic was interfered with and on certain lines was suspended. Basements and cellars in the low districts were flooded and merchandise had to be removed to the sidewalks and to upper stories. Several mills were obliged to close down. The crest reached Parkersburg, W. Va., 183 miles below Pittsburg, at 4 p.m. on the 24th, when a stage of 37 ft., or about 1 ft. above the danger line, was recorded. Little damage is done at this stage at Parkersburg. Cincinnati, Ohio, 468 miles below Pittsburg, had its highest water, about 53.3 ft., or 3.3 ft. above the danger line, about noon on Mar. 27. The flood stage of 50 ft. was reached on the morning of the 25th and residents in the low-lying districts began to move out of their houses. The water began to overflow some of the railroad tracks on the 26th, when the gage read 52.2 ft. at 8 a.m., but the service was not interrupted. A stage of 54 ft. or over at Cincinnati prevents trains from entering the Union Central Depot. The Mississippi River at Cairo, Ill., at the mouth of the Ohio, 967 miles below Pittsburg, was still rising on Apr. 1, when the gage registered 53.1, 8.1 ft. above the danger line, and the highest stage ever recorded there.

Car-lighting Statistics have recently been collected by a committee of the American Railway Association. The figures show conditions existing on Nov. 1, 1911, and cover 200 railways, having 227,100 miles of line and 54,961 cars in passenger-equipment service. A summary of the figures is as follows:

Lighting	Number	Per cent.
Oil	16,337	29.7
Gas	20,188	36.7
Electricity	6,893	12.6
Acetylene	1,228	2.2
Carburetor	1,150	2.1
Oil and electricity	2,347	4.3
Gas and electricity	3,864	7.1
Acetylene and elec.	983	1.8
Oil and gas	1,902	3.4
No lights	69	0.1
Total	54,961	100.0

The Proposed Reservoir System on the Allegheny and Monongahela Rivers

In our issue of Nov. 9, 1911, we described the general plan formulated by the Pittsburg Flood Commission for a system of reservoirs on the headwaters of the rivers which combine at Pittsburg to protect the city from floods. This plan has recently been examined by the National Waterways Commission, which recommends in its forthcoming report that the federal government investigate the plan through expert engineers with a view to federal coöperation.

The following are extracts from this forthcoming report as given by the chairman of the commission, Senator Burton, of Ohio, to the Pittsburg papers:

The commission believes that the federal government is justified in investigating the proposition to construct a system of reservoirs on the Allegheny, Monongahela and their tributaries, such as that recommended by the Pittsburg Flood Commission after its extended study of means for securing protection against further damage from floods, with a view to determining whether the federal government should coöperate with the localities in its construction. The commission accordingly recommends following the plan suggested in the preceding paragraph, that a preliminary investigation be made to determine whether such reservoirs are needed to supply sufficient water during dry seasons to operate the present and proposed system of locks and dams in the Allegheny, Monongahela and Ohio Rivers, and to what extent the federal government, on the basis of their benefit to navigation is justified in participating in the expense of their construction.

In order to ascertain these facts, the commission recommends that a joint board of engineers, one to be appointed from the corps of engineers, United States army, and one from the geological survey, be created by Congress to investigate this question and to report to Congress not later than the beginning of the next session, and that the sum of $5000 be appropriated to defray the expenses of this board.

A reservoir system intended for flood prevention should be more extensive than where intended primarily to benefit navigation or the development of water power. This is due to the fact that floods are caused by the combination of many factors and these combinations are never twice alike. A stream may exercise an important influence on the flood peak at one time and have little or no appreciable influence at another.

It is perfectly possible to operate a reservoir system if its capacity is sufficient so as to benefit navigation, develop power and prevent floods. But in such a case its utility for any one of these purposes is necessarily diminished. To obtain the maximum effectiveness for flood prevention, the reservoirs should be lowered as soon as possible after a heavy rain sufficiently to afford storage capacity to catch the water from the next storm. This means less power development and less benefit to navigation. It is quite possible that reservoirs operated in this way would be found practically empty during the summer months when the water which has been released earlier was needed for increasing the flow of streams. If reservoirs are operated primarily for navigation they are filled during the rainy season, and the water is held until needed during the summer months. If, after they are filled, a heavy rain should come, they would not be in a position to catch and hold any of it, and, therefore, could exercise no influence upon the flood level.

The commission has given special consideration to the feasibility of constructing reservoirs on the tributaries of the Ohio River. From the information obtained, it appears that such a plan has greater prospects of success here than in any other part of the United States. The damages caused by frequent floods in the Ohio are enormous. In the second place investigation shows that a large number of unusually good reservoir sites exist on the principal tributaries. Thirdly, the Ohio and Monongahela Rivers have a larger traffic than any other river in the United States and the government is now spending more than $60,000,000 to secure a 9-ft. navigation stage from Pittsburg to Cairo, Ill.

It is quite possible that when the commerce of the Ohio becomes greater, there may not be water enough during dry seasons to properly operate the locks which are being constructed. Such has already been the case on the Monongahela, where it has sometimes been found necessary to empty the upper pools in order to obtain sufficient water to make the lockages in the lower pools. Fourthly, the great industrial region around Pittsburg would doubtless offer a profitable market for water power that might be generated in connection with the establishment of a reservoir system. Finally, because of extensive investigations, more is known about the reservoir possibilities of this river basin than of any other.

The plan of impounding reservoirs on the tributaries of the Ohio to prevent floods and improve navigation was pointed out by M. O. Leighton, in his report to the Inland Waterways Commission in 1908.

Since that time the subject has been thoroughly investigated by the Pittsburg Flood Commission, which will soon publish an exhaustive report. This commission, composed of prominent engineers, examined in detail 43 reservoir sites on the Allegheny, Monongahela and the tributaries, with special reference to the prevention of damage from floods at Pittsburg. They recommend the adoption of a system composed of 17 reservoirs costing $21,672,000. The detailed estimates of their plan are shown by the following table:

	Allegheny	Monongahela	Combined
Total area controlled, sq. miles	8,023	2,159	10,182
Per cent	69.2	29.5	53.8
Total capacity, millions of cu.ft	42,178.5	17,302.9	59,481.4
Total cost of dams and appurtenances	$8,077,863	$3,101,131	$11,178,994
Total cost of land submerged	848,579	238,470	*1,078,049
Total cost, including damages	16,851,800	4,820,300	21,672,100

*28,289 acres at an average price of $38 per acre.

With the construction of a wall along the low lying portions of the river bank at Pittsburg, the flood commission believes that this system would be sufficient to protect the city against all but the most severe floods. A larger system of 28 reservoirs, costing about $28,000,000, and a still larger one of 43 reservoirs, costing $34,000,000, have been outlined and suggested as alternatives.

The extent to which this system of reservoirs will benefit the navigation of the Monongahela, Allegheny, and Ohio Rivers depends upon the amount of water that can safely be retained in the reservoirs until needed for low-water assistance. The flood commission estimates that the equivalent of 50% of the storage capacity of each reservoir could be retained for this purpose without impairing its efficiency for flood prevention.

Members of the corps of engineers, United States army, after an examination of the report of the Pittsburg Flood Commission, are of the opinion that the capacity of the system of 17 reservoirs which they recommend is not sufficient to prevent floods, and at the same time afford much benefit to navigation. The difficulty of reaching a final conclusion on this subject is due to the lack of complete and accurate statistics of rainfall and river discharge. The findings of the flood commission are, for this reason, based upon assumptions, the fairness of which it is difficult to determine.

M. O. Leighton, of the Geological Survey, however, suggests a plan of operating the reservoirs, by which the system of 17 could be effectively utilized, both for flood prevention and for aiding navigation. His plan is that the reservoirs should be operated primarily for flood prevention from about Nov. 1 to Apr. 1, and entirely for aiding navigation from about Apr. 1 to Nov. 1. A study of past floods shows that 80% occur between Nov. 1 and Apr. 1, and only 20% in months from April to November. Furthermore those occurring during the latter period are not as severe or as damaging.

Therefore, Pittsburg could well afford to remain subject to the occasional summer floods, in view of the practically complete relief from the violent ones of winter and spring. After the 17 reservoirs have been constructed and operated for a sufficient length of time to demonstrate their effectiveness, additional reservoirs could be built, if found necessary.

The communities interested in this project propose to raise a portion of the money required to carry it out by bond issues, and ask that the federal government, because of the benefit which will result to navigation, should coöperate with them by bearing a share of the expense and by authorizing the corps of engineers to construct and operate this system of reservoirs. They assert that prompt action is necessary or the most desirable reservoir sites which they have selected will be apropriated by private parties for the development of water power.

A Well Equipped Municipal Testing laboratory is now being installed in the city of St. Louis. This laboratory has been in existence for some years, but is now being increased to a marked extent. New quarters have been allotted it in the basement of the new Municipal Courts Building immediately adjacent to the City Hall and progress is being made toward the completion of the various parts of the laboratory. The equipment comprises a cement laboratory, a coal-testing laboratory, and a number of testing machines varying from the small briquette-testing machine to a 300,000-lb. tension and compression machine. It is intended that the purchase of all city materials shall be regulated by specification and accepted only under test by this laboratory.

Exhibition Test of Duplex System; New York High Pressure Fire Service

An exhibition test of the "duplex system" of high-pressure fire-service operation was made Apr. 2 at the Oliver St. pumping station in New York City. The plan of this system is to divide the system of high-pressure water mains into sections by means of motor-operated valves controlled by electric switches at the pumping station. The sections are arranged to be independently supplied with water from separate pumps. In case of a break in the main, which would be indicated at the station by a drop in pressure over the whole system, the motor-operated valves would be closed. The pressure will then remain low in the affected section, but it will rise again in the sections where there is no break and

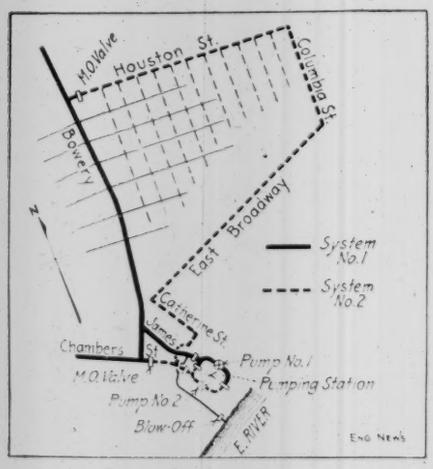

DIAGRAM OF "SWAMP DISTRICT" EXTENSION OF NEW YORK HIGH-PRESSURE FIRE SYSTEM

(Showing location of the control valves for duplex operation.)

the entire pump capacity can be concentrated, if required, on these sections.

The exhibition test was made on the extensions to the high-pressure service of the Borough of Manhattan, New York City, which cover the lower east side and the so called "swamp district"—bounded respectively by Chambers St., the East River, Houston St. and the Bowery, and by Chambers St., the East River, Nassau St. and Maiden Lane—and which have been designed for the duplex system of operation. The arrangement of the mains and the positions of the motor-operated valves (marked "M. O. valves") are shown by the accompanying diagram. There are two of these valves separating the mains into two sections, No. 1 and No. 2. The branches from the No. 1 and No. 2 sections form a network so that either section can supply practically the whole district as shown in the diagram.

In the tests the breaking of the main was simulated by rapidly opening the blow-off valve discharging from the No. 1 system into the East River. The test was begun with both motor-operated valves open and the blow-off closed. Pump No. 1 was started and the pressure raised to about 200 lb. over the entire system, as was indicated by pressure gages at the pumping station. The blow-off valve was then rapidly opened by hand and the pressure dropped to about 30 lb. in less than a minute. The switches controlling the motor-operated valves were then closed and at the same time pump No. 2 was started so as to maintain the supply of water to No. 2 section after the closing of the M. O. valves.

The closing of these valves, which required less than one minute, was indicated by green signal lights on the switchboard. After they had closed, the pressure gage on No. 1 section in which was the "break" remained at about 30 lb., while No. 2 gage rose quickly to 125 lb., the starting pressure of the pumps. Pump No. 2 was then speeded up to 200 lb. pressure and No. 1 was stopped. In case of an actual break in the main, pump No. 1 would have been shut off from No. 1 section and its discharge admitted to No. 2 section by opening one of the loop valves in the station.

Notes from Engineering Schools

BROWN UNIVERSITY—The library of the late George E. Church (see ENGINEERING NEWS, Jan. 13, 1910) has been placed in the college library of Brown University. These volumes show the varied interests of his career as surveyor, railroad engineer, explorer and soldier. They contain, also, rare volumes and large collections of publications, on South American countries, believed to be of great historical value.

Two Locomotive Boiler Explosions occurred, Mar. 29 and 30. The first was at East Worcester, N. Y., on the Delaware & Hudson Ry. The second was on the Cincinnati, Hamilton & Dayton Ry., near Tuscola, Ill. In each case, two men were killed and three others injured.

A Sawmill Boiler Exploded Mar. 26 at Delmar, Del. Five men, including the owner of the mill, were killed and four others were injured.

A Foundry Cupola Explosion at the McCormick Works of the International Harvester Co., at Chicago, Ill., Mar. 26, caused the death of three men and seriously injured eleven others. The cupola and the building in which it stood were wrecked. The explosion took place shortly after noon.

Extensive Floods throughout the Central States did much damage during the past week. The Ohio River was in flood at Pittsburg a few days earlier, as described in Mr. Grant's article on p. 660, of this issue, but began to subside after Mar. 23. About Apr. 1 there was another heavy rainfall throughout the Pittsburg district, but up to Apr. 3 the rivers there had not risen on account of it. Rains throughout the Missouri and Mississippi valleys added materially to the gage heights in those two rivers and they are rising at the latest reports. At Cairo, Ill., the combination of the floods in the Ohio and the Mississippi has brought about an unprecedented stage of water reaching, on Apr. 2, 1912, a height of 53.6 ft., or 1.3 ft. above the record. Business has been suspended at Cairo, and every one is engaged in patrolling the levees, which have not as yet shown any breaches. On account of the breaks in the levee at Hickman, Ky., and other places along the lower Mississippi, it is thought that the stage at Cairo will not pass 54 ft. The Cumberland River at Nashville reached, on Apr. 2, the danger stage of 40 ft. after a 26-ft. rise on the upper Cumberland, and a 50-ft. stage at Nashville is predicted. At Kansas City, the Missouri, and at Little Rock, Ark., the Arkansas Rivers are far above the danger mark and are overflowing the banks into business and residence districts. In Nebraska, extensive floods are tying up all railway traffic, and at Omaha, for the first time on record, there was not a train moving toward the West on Apr. 1. On the lower Mississippi, the river is still rising and, although the danger mark has been passed in several places, notably at Memphis, Tenn., greater heights of water are expected.

On Apr. 2 Congress passed a bill, at the urgent request of the President, appropriating $350,000 for strengthening the levees and building emergency protective works along the flooded rivers. The money becomes immediately available.

A Powder Mill Explosion, at Wayne, N. J., Apr. 1, at the Laflin & Rand Works of the Du Pont Powder Co., killed two men, one of whom was the superintendent, and badly injured three others. The finishing mill and two corning mills were destroyed. Reports state that the explosion originated in the finishing mill where there were four containers, each 20 ft. long by 15 ft. in diameter. These had been filled with black powder the night before, according to the reports, and one of the men killed had been seen to enter the mill shortly before the accident, for the purpose of opening them. It is noteworthy that the accident occurred a few minutes after eight o'clock on a Monday morning. Houses were shaken throughout the Passaic valley and the shock was distinctly felt in Staten Island and in Brooklyn, more than 20 miles from the mill.

At Tulsa, Okla., Mar. 30, the plant of the Central Torpedo Co. was wrecked by an explosion of nitroglycerin. Four persons were reported missing.

Record for 70-Ton Steam Shovel—On Mar. 14, 1912, steam shovel No. 124, a 70-ton shovel of the Bucyrus make, loaded 290 small Western dump cars, containing a total of 2900 cu.yd. of material in the working day of eight hours. During this period the shovel was delayed one hour and 50 minutes waiting for cars.

This is the highest daily output for a 70-ton shovel since the commencement of operations by the United States.—"Canal Record."

Pennsylvania R.R. Statistics for the year ending Dec. 31, 1911, show that railways owned or leased and operated by the Pennsylvania System totaled 25,236.5 miles, or more than enough to encircle

the earth. Of this mileage 11,503.76 miles are first track, 3593.03 second track, 798.41 third track, 619.03 fourth track and 8722.27 miles are sidings. This mileage is in 13 states and the District of Columbia. On Mar. 1 of the present year there were 73,567 stockholders of the Pennsylvania R.R., not including those of its various subsidiaries.

The Long-Distance Balloon Record has been awarded by the Aero Club of France to Emile Dubonnet for a 1953.9-km. (1214.1 miles) trip made in a non-dirigible from Lazmotte-Bruille, France, to Sokolowska, Russia, Jan. 7-8, 1912. The previous record was held by the Count de la Vaulx for a flight of 1193 miles from France into Siberia. It will be remembered that the balloon "America II" in the international races from St. Louis, Mo., to eastern Ontario, in October, 1910, made a trip which was at first reported to be 1355 miles, but which turned out to be only 1171 miles.

Further Developments in the Florida Everglades drainage investigation occurred on Apr. 1, when indictments were returned by the Federal Grand Jury at Washington, D. C., against C. G. Elliott, A. D. Morehouse, P. T. Teele and F. E. Singleton. The defendants are charged individually with having approved or presented false vouchers against the government. Mr. Elliott is reported as having said:

> The indictment against me is neither a surprise nor a matter of concern. It is only another step in a persecution, the reasons for which are already known to many, and will in good time be apparent to all.

The following is a copy of a letter sent to President Taft and to Secretary of Agriculture Wilson, on Mar. 15:

> Sir—The Illinois Society of Engineers and Surveyors, represented by its officers and Executive Committee, desires to register strong and emphatic protest against what is regarded as the arbitrary, unjust and unreasonable action in the summary discharge of Mr. C. G. Elliott, Chief of Drainage Investigations.
>
> Mr. Elliott is well known in this Society (of which he is an honored member) and through the Central States and the West, both for his practical work in drainage engineering and for his investigation of the general subject of land reclamation by drainage. Of his competency as an engineer and expert there is no question. Of his integrity, faithfulness and proper action in the public interest we consider that there is no question.
>
> We do question the grounds upon which the action of the Department was based, and we cannot believe that the Department has acted fairly or in the public interest in its attack upon Mr. Elliott.
>
> We desire to see Mr. Elliott reinstated and reparation made him, so far as reparation can be made after this attack upon his integrity. Also that any investigation shall be conducted in a competent, impartial and fair minded manner, and not left to those who may have unworthy personal or political motives for avoiding a fair and full hearing.
>
> Respectfully,
> Jacob A. Harman,
> President.
> E. E. R. Tratman,
> Secretary.

Negligence in Maintaining the sides of an irrigation canal and not an act of God, is found by the Supreme Court of the State of Washington to be the cause of a break which flooded a farm near Olympia. The decision affirms the action of the lower court, which awarded damages to the farmer whose lands were inundated.

A Committee on New York City Pavements, appointed by Mayor Gaynor in October, 1911, and headed by Ernest Flagg, a New York architect, published its report Mar. 30. The report reviews the poor conditions existing and makes many recommendations. Among these the following may be noted: (1) widening of the streets in lower Manhattan by using the porch areas in front of buildings now occupied by property owners; (2) undivided control of streets by borough presidents; (3) the right to purchase paving materials by the city from producers; (4) city engineers to be sent abroad to study; (5) repairs to be done by the city and at night; (6) boroughs to have their own repair plant; (7) all dead tracks to be removed; (8) curbs to be beveled in accordance with English practice; (9) trial to be given of the French method of flushing gutters; (10) trial of plan of dumping snow into manhole and flushing away with water; (11) granite instead of blue stone to be used for curbing; (12) improved gratings to be used on catch-basins in Manhattan; (13) stone-block pavements for all streets below 23rd St., except cross streets in the tenement district and in a few small areas retaining residential character and in financial districts where there is not much heavy trucking; (14) stone block for all streets above 23rd where there is heavy trucking; (15) sheet asphalt or wood-block pavement for residential- and tenement-district streets; (16) asphalt, wood blocks or small granite cubes for streets with heavy automobile traffic; (17) for sections where property values do not warrant first-class sheet asphalt or wood blocks, an approved bituminous macadam with brick gutters and intersections; (18) concrete foundations (except for macadam) varying in thickness from 4 to 8 in., according to traffic; (19) no more asphalt-block pavement to be laid in any borough until their use has been determined to be as economical as sheet asphalt.

Personals

Mr. E. D. C. Chisholm has been appointed Resident Engineer of the Canadian Pacific Ry., at Winnipeg, Man.

Mr. J. E. Willoughby, M. Am. Soc. C. E., Engineer of Construction of the Louisville & Nashville R.R., has resigned.

Mr. R. E. Wells, General Manager of the San Pedro, Los Angeles & Salt Lake R.R. since its opening in 1901, has resigned.

Mr. George V. S. Williams, a lawyer, of New York City, has been appointed a member of the Public Service Commission of the First District of New York, succeeding Mr. Wm. McCarroll.

Mr. John Leroy Mann, M. Am. Soc. C. E., for a number of years employed in the public works department of the Republic of Santo Domingo, has been appointed Director General of Public Works there.

Mr. William P. Robinson has been elected President of the Denver Union Water Co., Denver, Colo., succeeding the late Thos. S. Hayden. Mr. Robinson has been General Manager of the company for the past 12 years.

Mr. V. H. Dill, who has been Designing and Estimating Engineer of the Central States Bridge Co., of Indianapolis, Ind., for a number of years, has been appointed Chief Engineer of the Pan-American Bridge Co., of New Castle, Ind.

Mr. Aldis E. Hibner, Assoc. Am. Inst. E. E., Power Engineer of the Livingston Niagara Power Co., Avon, N. Y., has resigned to accept the position of Electrical Commercial Manager of the Empire Gas & Electric Co., of Auburn, N. Y.

Mr. Carroll Beale, Assoc. M. Am. Soc. C. E., formerly Contracting Engineer in charge of the eastern district of the Pittsburgh Steel Products Co., of Pittsburg, Penn., has opened an office in the Woodward Bldg., Washington, D. C., as a structural engineer.

Mr. J. G. Thorne, formerly Assistant Engineer and Superintendent for the Iowa Engineering Co., Iowa City, Iowa, has been elected City Engineer of Clinton, Iowa. Mr. Thorne is a graduate in civil engineering of the University of Wisconsin, class of 1906.

Dr. Alexander Graham Bell, M. Am. Inst. E. E., has become Editor of the "Volta Review," published by the American Association to Promote the Teaching of Speech to the Deaf, an organization founded by Dr. Bell and in which he has always been actively interested.

Mr. Horace C. Grout, formerly Assistant Superintendent of the Canadian Pacific Ry., at Havelock, Ont., has been promoted to be Superintendent at Toronto, Ont. Previous to 1909, Mr. Grout was rodman, instrumentman and Resident Engineer of the Canadian Pacific Ry.

Messrs. F. M. Bowman, Secretary, Wayne Rawley, Manager of the structural works and A. Bovard, Engineer, of the Riter-Conley Manufacturing Co., of Pittsburg, Penn., have resigned their positions and are organizing a manufacturing concern in conjunction with the Blaw Steel Centering Co., also of Pittsburg.

Mr. E. J. McCaustland, M. Am. Soc. C. E., Professor of Municipal Engineering at the University of Washington, Seattle, Wash., has been appointed a member of the Washington State Board of Health. For the past three years Prof. McCaustland has been Consulting Sanitary Engineer for the Board.

Mr. D. C. Tuttle, formerly with the Stone & Webster Engineering Corporation, of Boston, Mass., and more recently of the engineering department of the Spring Valley Water Co., of San Francisco, Calif., has been appointed Manager of the machinery department of David Bixler & Co., of San Francisco.

Mr. Thomas J. Rout, Jr., has been appointed Lighthouse Inspector in charge of the Fourth District, covering Delaware Bay and River, with headquarters in Philadelphia, Penn. He has been in the Lighthouse Service for 18 years, and for the past two years has had charge of the design and construction work in his present district.

Mr. Edward C. Gillette has been appointed Lighthouse Inspector in charge of the Second District, covering the coasts of New Hampshire and Massachusetts, with headquarters at Boston, Mass. Mr. Gillette has been connected with the Lighthouse Service since 1903, and has been largely engaged on construction and repair work of vessels.

Mr. Charles E. Schaff, Vice-President of the Cleveland, Cincinnati, Chicago & St. Louis R.R., at Chicago, Ill., has resigned to accept the office of President of the Missouri, Kansas & Texas Ry., succeeding Mr. A. A. Allen, resigned. Mr. Schaff began his railway career as a brakeman on the Pittsburg, Cincinnati & St. Louis Ry., in 1871.

Mr. Albert E. Guy, M. Am. Soc. M. E., for six years Chief Engineer of the De Laval Steam Turbine Co., of Trenton, N. J., is now Chief Engineer of the Wilson-Snyder Centrifugal Pump Co., of Pittsburg, Penn., a company organized in connection with the Wilson-Snyder Manufacturing Co., to make a new line of centrifugal pumps, after designs by Mr. Guy.

Mr. H. F. Weber, Jun. Am. Soc. M. E., has resigned his position as Mechanical Engineer of the Electric Bond & Share Co., New York City, and become associated with Mr. James Gamble, under the firm name of Gamble & Weber, with offices at 15 William St., New York City. The new firm is to finance, construct and operate public utilities for water, gas and electricity.

Mr. Ray H. Hankinson has been appointed Lighthouse Inspector in charge of the Sixteenth District, embracing the coasts of Alaska, with headquarters in Ketchikan, Alaska. Mr. Hankinson has been in the Lighthouse Service since 1905, and in the past year has had charge of the design and construction work of about 40 new lights and other aids to navigation in Alaska.

Messrs. J. A. Colby and A. J. Christie have formed a partnership under the firm name of Colby & Christie, for the inspection of materials and workmanship of bridges, viaducts and buildings, with offices in the Witherspoon Bldg., Philadelphia, Penn. Mr. Colby has been an inspecting engineer at the same address for several years, and Mr. Christie has been Engineer of Tests at the Ambridge plant of the American Bridge Co.

Messrs. Charles W. Staniford, Chief Engineer of the Department of Docks and Ferries; E. P. Goodrich, Consulting Engineer, Borough of Manhattan, and William J. Barney, Second Deputy Commissioner of the Department of Docks and Ferries, all of New York City, who were appointed a Board of Consulting Engineers to examine and report upon plans for the improvement of the port facilities of Portland, Ore., as noted in our issue of Dec. 7, 1911, have completed their work and have forwarded their report to the Public Dock Commission of Portland. The report recommends definite plans and selects sites for the immediate expenditure of $2,500,000, the amount at present authorized by a bond issue. It also recommends definite plans and steps leading up to future bond issues aggregating $30,000,000 for the extension and completion of the improvements in the harbor. The report is an extensive presentation of harbor development in general, consisting of about 250 pages and 28 maps and plates, all of which will probably be published in the near future.

Obituary

Dr. Antonio Pacinotti, Hon. M. Am. Inst. E. E., Professor of Physics and Technology, at University of Pisa, Pisa, Italy, died on Mar 24. He constructed the first commercial type of electric generator in 1861.

John Parker Reynolds, Director-in-Chief of the World's Columbian Exposition at Chicago, Ill., in 1891-93, died at his home in Chicago, on Mar. 27, at the age of 92 years. During the Civil War period he was President of the Illinois State Sanitary Commission.

Conrad Miller, an old-time Pennsylvania railroad contractor, died at his home in Nazareth, Penn., on Mar. 29. He was 74 years old and a native of Germany. He was contractor for a portion of the Baltimore & Ohio R.R., and was one of the organizers of the Bangor & Portland R.R. Co. He was also extensively interested in slate and cement companies in Pennsylvania.

John Arbuckle, who was known to engineers for his persistent attempts float the U. S. Cruiser "Yankee" in Buzzards Bay in 1908 and 1909, died at his home in Brooklyn, N. Y., on Mar. 27, aged 74 years. He was known chiefly as a millionaire coffee and sugar merchant and philanthropist, but during his later life became interested in the ocean wrecking business. Mr. Arbuckle's company was successful in raising the "Yankee" after many previous attempts made by the Government, but unfortunately she was rammed by a tug and sank again before she could be towed into New Bedford Harbor. His company was also successful in raising the U. S. Collier "Nero," which sank off Newport in 1909.

Thomas Greene, Chief Engineer of the Minneapolis, St. Paul & Sault Ste. Marie Ry., died on Mar. 27, at his home in Minneapolis. Mr. Greene was born in Green Bay, Wis., in 1865. He had been in the employ of the engineering department of the Minneapolis, St. Paul & Sault Ste. Marie Ry. for 20 years, during 12 of which he was Chief Engineer. The recent work done under his direction in the construction of the short line from St. Paul to Duluth, the improvement of the Chicago division, formerly the Wisconsin Central R.R., the shortening of the line between New Richmond and St. Paul, securing an entrance into St. Paul by tunneling under other railways and what is known as Bunker Hill, the terminal improvements and station at Duluth, the construction of the cutoff from Duluth to Thief River Falls, and other extensive improvements, comprise a record of achievement of which any engineer might be proud. As a man he was always looking after the interests of his company, at the same time dealing with absolute fairness to the many contractors with whom he came in contact. He had the unusual faculty of presenting his position in a manner which carried conviction as to his fairness and left him the respect and good will even of those whose claims he may have decided against. Few men have ever built up an organization more loyal than did Mr. Greene; and this loyalty and esteem was the result of respect for the true ability of the man as an engineer and his fairness and willingness to consider carefully any suggestion for the betterment of any work in hand, thus encouraging the best efforts on the part of every member of his staff.—Prepared by C. A. P. Turner, M. Am. Soc. C. E., Minneapolis, Minn.

Engineering Societies

COMING MEETINGS

NATIONAL DRAINAGE CONGRESS.
April 10-13. Annual meeting at New Orleans, La. Vice-President, E. T. Perkins, First National Bank Bldg., Chicago.

MONTANA SOCIETY OF ENGINEERS.
April 11-13. Annual meeting at Anaconda, Mont. Secy., Clinton H. Moore, Butte, Mont.

AMERICAN ELECTROCHEMICAL SOCIETY.
April 18-20. Annual meeting at Boston, Mass. Secy., J. W. Richards, Lehigh University, South Bethlehem, Penn.

AIR BRAKE ASSOCIATION.
May 7-10. Annual convention at Richmond, Va. Secy., F. M. Nellis, 53 State St., Boston, Mass.

NATIONAL FIRE PROTECTION ASSOCIATION.
May 14-16. Annual meeting at Chicago. Secy., F. H. Wentworth, 87 Milk St., Boston, Mass.

MASTER BOILER MAKERS ASSOCIATION.
May 14-17. Annual convention at Pittsburg, Penn. Secy., H. D. Vought, 95 Liberty St., New York.

AMERICAN RAILWAY ASSOCIATION.
May 15. Semi-annual meeting at New York City. Secy., W. F. Allen, 75 Church St., New York.

OHIO SOCIETY OF MECHANICAL, ELECTRICAL AND STEAM ENGINEERS.
May 16-18. Annual meeting at Pittsburg, Penn. Secy., F. E. Sanborn, Ohio State University, Columbus, Ohio.

INTERNATIONAL RAILWAY FUEL ASSOCIATION.
May 22-25. Annual convention at Chicago, Ill. Secy., D. B. Sebastian, La Salle St. station, Chicago.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS.
May 28-31. Spring meeting at Cleveland, Ohio. Secy., C. W. Rice, 29 West 39th St., New York.

AMERICAN WATER WORKS ASSOCIATION.
June 3-8. Annual convention at Louisville, Ky. Secy., J. M. Diven, 271 River St., Troy, N. Y.

ASSOCIATION OF RAILWAY TELEGRAPH SUPERINTENDENTS.
June 4. Annual convention at New York City. Secy., P. W. Drew, Soo Line, Chicago, Ill.

American Institute of Chemical Engineers—The semi-annual meeting which is usually held in June will be held this year in September in connection with the meeting of the International Congress of Applied Chemistry, which meets at Washington and New York, Sept. 4-12.

Brooklyn Engineers' Club—At the meeting of Mar. 28, Robert D. Hall, Associate Editor of "Coal Age," gave a talk on the anthracite coal situation. He expressed the opinion that the coal-miners' union was anxious to force a strike, explaining this attitude as follows:

The coal-miners' union is quite weak in the anthracite region, and hopes to strengthen itself through agitation and a strike. If success is obtained by arbitration, the miners will be prone to believe that it was due to elements over which the union had no control.

Society of Automobile Engineers—The society's headquarters will be removed about May 1 from the present address at 1451 Broadway, New York City, to the United States Rubber Bldg., at Broadway and 58th St., in the same city. A committee appointed to investigate the subject of new quarters for the society decided that some 1500 sq.ft. of floor space would be required. In addition to the society's offices, there will be a members' room and library. The members' room will have large windows facing north, overlooking Central Park, Columbus Circle and Upper Broadway. The room is laid out so as to give a large amount of wall space for book shelves, and for a proper display of the standards of the society.